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Nos. 776–800,

WITH CONTENTS AND INDEX.

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GROWING CHERRIES EAST OF THE ROCKY MOUNTAINS

Rev Jan 1941

H. P. GOULD

Pomologist in Charge of Fruit-Production Investigations

FARMERS' BULLETIN 776

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. December, 1916

GROWING CHERRIES EAST OF THE ROCKY MOUNTAINS.

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EXTENT AND DISTRIBUTION OF CHERRY GROWING.

The Thirteenth Census reports for the entire country a total of 11,822,044 cherry trees of bearing age, and about one-half as many not of bearing age. Probably no tree fruit is grown more widely throughout the country than the sour cherry, or "pie" cherry, as it is often called. The distribution of sweet cherries is more restricted. The nearly 12,000,000 trees of bearing age reported by the last census are distributed in every State in the Union and range in number in the different States from 120 in Florida to more than 1,000,000 in each of the States of Pennsylvania and Ohio, followed closely by several other States. However, in most of the States in each of which there are a million trees or nearly that number, the commercial interests are relatively small compared with several others in which the number of trees is considerably less. In the latter the industry is largely centralized in certain localities or regions where the commercial interests are extensive, while in the former the trees are distributed quite generally throughout the States, principally as small orchards, the fruit of which is rarely shipped, though in many cases it may be sold in local markets.

Climate is the most potent limiting influence in the distribution of fruits so far as the natural surroundings are concerned. Of the various elements of climate, temperature probably more often governs in this respect than any other single factor. This becomes evident in the distribution of cherries.

NOTE.—This bulletin is intended for those who are interested in growing cherries in that part of the country which lies east of the Rocky Mountains.

Cherry trees do not thrive well as a rule where the summers are particularly long and hot. For this reason more than any other they are grown but little in the South, and to the limited extent they are planted in that part of the country the best success is attained at the higher altitudes.

In their endurance of low temperatures the widely grown sour-cherry varieties approach the apple varieties which are grown commonly in the northern commercial apple-producing districts.

The most important commercial sour-cherry orchards are located in the Hudson River valley, in western New York, western Michigan, northern Ohio, the Arkansas River valley in Colorado, Door County, Wis., parts of Iowa, and to a lesser extent in other States. Large quantities of cherries in the aggregate are produced in States and sections not specifically mentioned, but as a rule the orchards are small and do not represent important community interests.

The leading varieties of sweet cherries are less hardy than the best known sour sorts. Their endurance of cold corresponds more nearly to that of the peach. It may be doubted whether sweet cherries as a group endure long, hot summers any better than the sour sorts, possibly not as well.

The most important sweet-cherry producing regions are in the Pacific Coast States, where the sour cherry is almost unknown. East of the Rocky Mountains the commercial production of sweet cherries is confined very largely to the Hudson River valley, western New York, and western Michigan. In the two latter sections the climate is much modified by the influence of the Great Lakes. While sweet-cherry trees are more or less widely distributed throughout a large portion of the country the number of trees aside from those in the sections mentioned is comparatively small.

LOCATIONS FOR CHERRY GROWING.

In selecting a location for cherry growing—that is, the general region or community in which the enterprise is to be developed—several things need to be considered with much care. The general relation between climatic conditions and the geographic distribution of commercial cherry culture has been mentioned. As the fruit is very perishable, quick transportation to market is essential, and also refrigerator service if the fruit is to be shipped long distances; and, further, a relatively large crew is required to handle the fruit properly. Large orchards therefore should not be located where it is practically or economically impossible to assemble and care for the requisite labor to handle the fruit properly.

SITES FOR CHERRY ORCHARDS.

The "site" is the exact piece of land occupied by the trees. The same general factors which require consideration in selecting a site for an apple or peach orchard need to be taken into account in choosing sites for cherries. The most important of these factors are soil and local climatic conditions.

Cherry trees thrive on a wide range of soil types, provided the soils are well drained. There is, perhaps, no fruit tree more sensitive to the ill effects of a poorly drained soil than the cherry. In many important cherry-growing regions the prevailing types of soil are rather light—sandy, sandy loams, and other light loams—commonly underlain with a more or less clayey subsoil. Such soils characterize the areas bordering the Great Lakes, where the most important commercial interests east of the Rocky Mountains are located. However, the industry doubtless has developed in these regions because of the climatic conditions which are induced by the large bodies of water that they adjoin rather than because of the existence there of any particular soil types; but, as the heavier clayey types are often extremely retentive of moisture or otherwise insufficiently drained for good results with cherries, it obviously follows that the comparatively light soils are preferred for this fruit. For sweet cherries the lighter, warmer types are usually regarded as essential for successful results. Soils that are especially "droughty" and dry out excessively are unsatisfactory for either type of cherry. Moderately productive soils give better results than those which represent either extreme in fertility.

The temperature factor in its influence on the geographic distribution of cherry growing has been mentioned, but in its relation to local conditions this factor also requires consideration. Cherries blossom comparatively early, the sweet sorts earlier in most cases than the sour varieties; therefore, sites that are subject to spring frosts during the usual blossoming period should be avoided.

As cold air settles to the lower levels, orchards occupying sites somewhat higher than the surrounding areas are generally less liable to frost injury than those having a comparatively low elevation. The soil of the higher areas is also likely to be better drained than that which occupies the lower levels.

PROPAGATING CHERRY TREES.

The details of propagating cherry trees are of little direct importance to the average grower, as he will usually find it to his advantage to buy trees from a reputable nurseryman. Trees are propagated by budding on seedling stocks in the nursery row and are commonly sold for planting either as 1 or 2 year old trees. Trees which have made one season's growth in the nursery are designated as 1-year-old trees; by the same rule, a 2-year-old tree is one that has made two seasons' growth from the bud, though it may lack several months of being 2 years old.

STOCKS FOR CHERRY TREES.

Though the average cherry grower rarely has occasion to propagate cherry trees himself, the kind of stock on which his trees are propagated is a matter of importance to him.

Two kinds of stocks, the mahaleb[1] and mazzard,[2] are in common use. These are two distinct types of cherries, which are of value for stocks but unimportant for their fruit.

The mahaleb is used much more extensively than the mazzard, and for the sour varieties it generally gives fairly good satisfaction. While the mahaleb is much used in propagating sweet cherries, growers who have studied the matter carefully are closely in accord in their conviction that the sweet sorts give much better results when grown on mazzard than on mahaleb stocks. The mazzard stock appears to increase the vigor and length of life of trees propagated on it in comparison with the mahaleb.

Moreover, some growers express a definite preference for the mazzard as a stock for sour as well as for sweet cherries, their choice being based on the stronger and more vigorous growth sometimes made by trees propagated on mazzard stocks when compared with those on mahaleb stocks grown under the same conditions.

From the nurseryman's standpoint the mazzard is a rather difficult stock to use. Its condition with reference to budding is quickly influenced by weather factors; if they are unfavorable, the buds may not "take" readily.

The common wild "bird" or "pin" cherry[3] has been used to a limited extent in some sections for stock purposes, but it is unimportant in comparison with the others mentioned.

TREES FOR PLANTING.

The selection of trees suitable for planting is fundamental to the success of an orchard. To plant a poor tree is to start with a handicap that may continue throughout the life of the orchard. The purchase price of a poor tree may be a few cents less than that of one of high grade, but the economy of the transaction ends with its purchase. Everything else costs substantially the same as for a high-grade tree. Real economy consists in paying reasonable prices for high-grade trees. If only a definite amount can be expended for trees, it is better to secure a small number of good, strong, well-rooted, well-formed trees than to buy a larger number at the expense of quality. An altogether desirable tree is difficult to describe, especially as different planters have different ideals. The desirability of a tree is not measured by size alone. While a small, inferior tree should be avoided because it is not likely to grow well even when planted under favorable conditions, a very large, overgrown tree is scarcely better. Unless handled with extreme care, the largest grades do not endure the check incident to transplanting as well as thrifty medium-sized trees.

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[1] *Prunus mahaleb.* [2] *Prunus avium.* [3] *Prunus pennsylvanica.*

In the past, 2-year-old trees have been planted, as a rule, by cherry growers, but there is evidently a growing preference for trees that have made only one season's growth in the nursery. Good-sized 1-year-old trees usually give satisfaction. They are light to handle, transportation charges are less than for the heavier trees, the root systems are but little reduced in digging from the nursery, they start into growth readily, the tops can be formed largely in accordance with the grower's own ideals rather than by the nurseryman, and the cost is usually a little less than for older trees of corresponding grades.

The different grades are commonly designated by the height of the trees, as 3 to 4 feet, 4 to 5 feet, 5 to 6 feet, etc. The size of the trunk, or caliper, is sometimes considered and designated as follows: Five-eighths to three-fourths, 4 to 5 feet; three-fourths up, 5 to 7 feet, etc. Here the fractions denote in parts of an inch the diameter of the trunk just above the point of union of stock and bud, and the whole numbers indicate the height of the trees. In the last form, "three-fourths up" means trees having a diameter of trunk of three-fourths of an inch or more. Still another method is where the height of the different grades overlaps, as 4 to 5 feet, 4½ to 6 feet, 5 to 7 feet, these terms being equivalent to small, medium, large. These grade designations are based on caliper as well as height, though the caliper is not stated. Thus, a tree 6 feet high, if it has sufficient caliper goes in the 5 to 7 foot grade; otherwise, it may be put in the 4½ to 6 foot or medium grade.

The relative significance of these grade terms will be better understood by referring to figures 1 and 2 and the explanations which accompany them.

THE SEASON FOR PLANTING TREES.

In regions where the winters are severe and trying, spring planting is advisable. Such conditions occur in the North, where the temperature drops very low, and in the Great Plains area, where, in addition to low temperatures, the winters are very trying because of the limited supply of moisture both in the soil and in the atmosphere. In the middle latitudes and wherever the winters are comparatively mild, fall planting generally is preferable.

One factor in spring planting needs to be observed with special care. The buds of cherry trees swell and start into growth very early. If they start to any considerable extent before the trees are planted, a high percentage of failure is likely to occur. Therefore, particular pains should be taken to hold the trees in a perfectly dormant condition until they are set out, very early planting usually being the wisest plan.

HANDLING THE TREES WHEN RECEIVED FROM THE NURSERY.

The trees should be unpacked immediately after delivery and every possible precaution taken to prevent the roots from becoming dry. Unless the number of trees is so limited that immediate planting is possible and the time for doing it is at hand, they should be heeled in. For this purpose a thoroughly well drained place where the soil is mellow and deep is required. A trench sufficiently wide and deep to receive the roots is made, and the trees are placed in it in the manner shown in figure 3. In covering, the soil should be worked among the roots sufficiently to fill all the spaces between them. If a large number of trees are to be heeled in, they are usually placed in closely adjacent rows. Where this is done, the trees in one row may be covered with the soil which is removed in opening the adjacent trench.

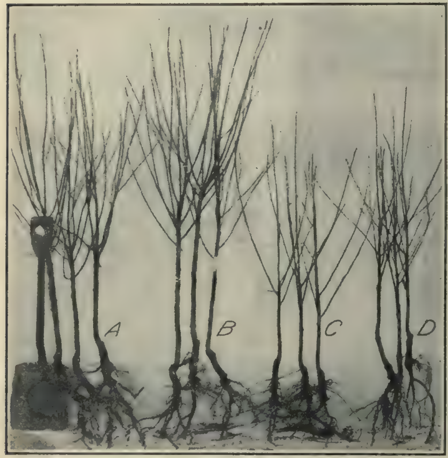

Fig 1.—Sour-cherry trees representing different grades of nursery stocks, as follows: *A*, 2-year-old Large Montmorency on mazzard stocks, three-fourths inch up, 5 to 7 feet; *B*, same as *A* except that trees are on mahaleb stocks; *C*, 1-year-old Montmorency on mazzard stocks, five-eighths to eleven-sixteenths inch, 3 to 4 feet; *D*, 1-year-old Large Montmorency on mahaleb stocks, five-eighths to eleven-sixteenths inch, 3 to 4 feet.

Trees that are tied in bundles when received must be separated before they are heeled in. If this is not done it is difficult to work the soil among the roots sufficiently to prevent them from drying to a serious extent. If it is necessary to leave trees heeled in over winter, they should be placed in a nearly horizontal position, so that the entire trunk below the branches can be covered with soil, for protection.

PREPARING THE LAND.

The ideal preparation of the soil for cherry trees consists of deep plowing and thorough pulverizing with a harrow or cultivator. The preparation should be hardly less thorough than for corn, potatoes, or other hoe crops. Though various compromises on this ideal may be possible without defeating the ends in view, any temporary gain through a course that falls short of a thorough and deep working and fining of the soil will usually be more than offset by the results that follow.

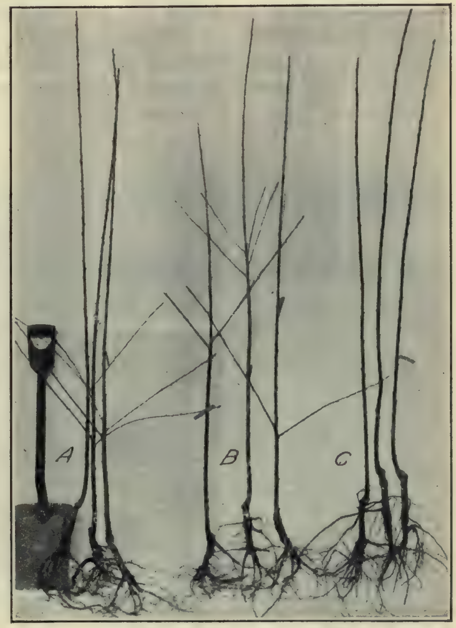

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FIG. 2.—Sweet-cherry nursery stock: *A*, 1-year-old Windsor trees on mahaleb stock, five-eighths to eleven-sixteenths inch grade (the branching is characteristic of this variety); *B*, same as *A* except that the trees are on mazzard stocks; *C*, 1-year-old Schmidt trees on mahaleb stocks, five-eighths to eleven-sixteenths inch grade.

PLANTING THE TREES.

Cherry trees are planted at various distances apart, depending upon the topography of the land, the fertility of the soil, the varietal characteristics of the trees, and the preferences and conceptions of the individual grower. For most sour varieties, 20 by 20 feet is generally accepted as satisfactory. Many who have orchards of trees of considerable age that are planted closer than this concede that they are too near together. Occasionally a grower is found who is convinced that 22 or even 25 feet apart each way gives none too much space for the strong-growing varieties like the Montmorency. Some of the smaller-growing sorts, such as the English Morello, are sometimes planted 16 or 18 feet apart each way with good success.

The ill effect of too close planting is suggested in figure 4, which shows a Montmorency orchard about 21 years old in which the trees are 14 feet apart each way. The branches interlock, so that spraying is difficult; they are long, slender, and upright in position, and hence it is difficult to gather a considerable part of the crop.

A good many sweet-cherry trees have been planted 20 by 20 feet, but this is admittedly too close. Probably 25 feet each way is the minimum distance advisable for sweet cherries, while not a few growers prefer from 28 to 32 feet each way, in the conviction that in the end the greater amount of space is more satisfactory.

East of the Rocky Mountains commercial plantings of sweet cherries have been made almost invariably in connection with sour varieties, and with few exceptions comprise but a very small proportion of the orchards in which they occur. It is therefore a matter of convenience to space the trees of the sweet varieties the same as the sour sorts; but because of the much larger size attained by the former more space should be given them wherever possible.

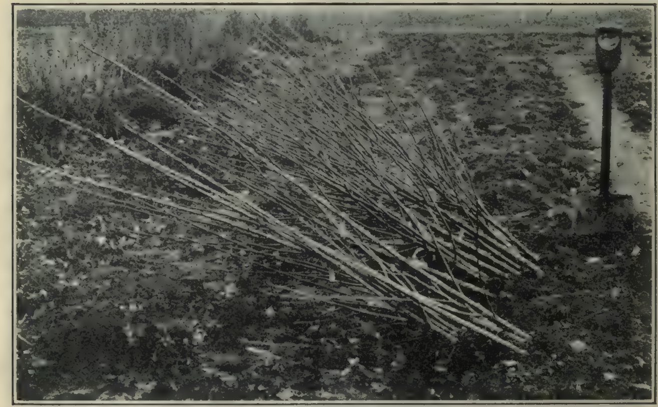

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FIG. 3.—Cherry trees heeled in.

The details of planting the trees, so far as placing them in the ground is concerned, do not differ from those usually followed with apples, peaches, or other fruit trees commonly planted in the sections where cherries are grown.

In preparing a tree for planting, all mutilated or injured portions of the roots should be trimmed off and long, slender roots, if they occur, cut off to correspond with the length of the main roots.

In handling the trees every precaution should be taken to prevent the roots from becoming dry. Undue exposure during the period that elapses between the trimming and the planting of the trees will injure them. This danger can be eliminated largely by puddling the roots as soon as trimmed. This consists in dipping them in a puddle of clay. The puddle should be of such consistency that a thin layer of mud will adhere to the roots when dipped into it. Such a coating of mud will afford considerable protection, though even with this treatment the exposure of the roots to sun and wind should be reduced to a minimum at all times If only a few trees are to be planted, it may be more convenient to protect them by keeping the roots covered with wet gunny sacks or some other coarse fabric.

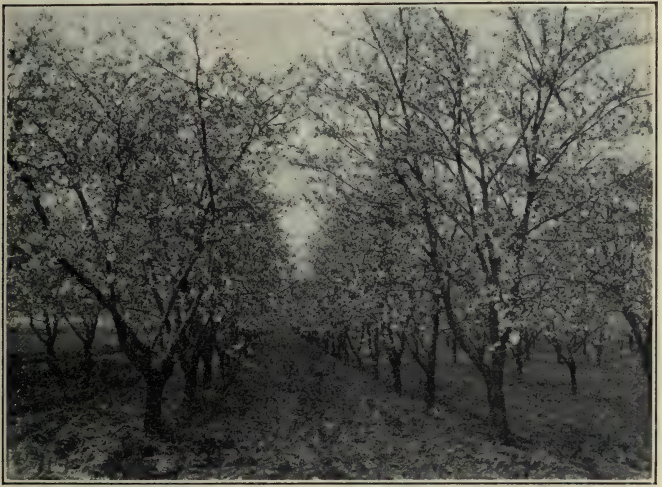
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FIG. 4.—A Montmorency cherry orchard about 21 years old. The trees stand 14 feet apart each way. They are tall and the branches are long and slender, as a result of being planted too close together. (New York, May 6, 1915.)

In planting the trees after they have been prepared as above suggested, several very important precautions must be observed if the desired success is to be realized. In filling the hole after a tree has been put into position and properly aligned only finely pulverized soil should be used. In this part of the operation much care should be taken to work the soil in closely about the roots. This may be done to some extent with the fingers. Moving the tree up and down very slightly as the hole is being filled will also materially help to settle the soil among the roots. As the filling progresses the soil should be firmly tamped about the roots, and when completed the hole should be filled even with the surface.[1]

PRUNING AT THE TIME OF PLANTING.

Wide differences exist in the manner of pruning and forming the tops of the trees at planting time, though they may be grouped into two general methods: (1) Forming the top with three to five or six main framework branches of equal importance, and (2) forming the top with a central leader and with several secondary branches which radiate from it. A practice followed by not a few is to plant the tree without shaping the top and with little or no heading back of the branches or other pruning. This practice calls for no comment other than a statement of disapproval. The two principal methods, however, require discussion in considerable detail.

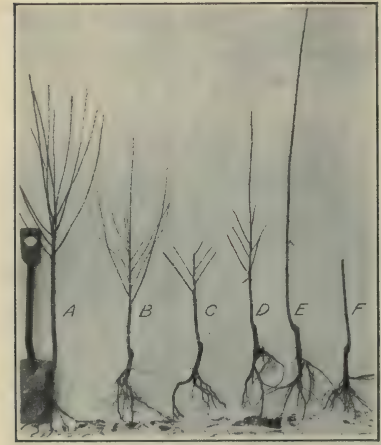

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FIG. 5.—Cherry trees of the grades illustrated in figures 1 and 2, showing the methods of shaping the tops used when planted: *A*, a 2-year-old Large Montmorency, unpruned; *B*, a 1-year-old Large Montmorency, unpruned; *C*, same as *B*, pruned to be grown with an open center; *D*, a 1-year-old Large Montmorency, pruned to be grown with a central leader; *E*, a 1-year-old Schmidt, unpruned; *F*, same as *E*, headed back ready for planting.

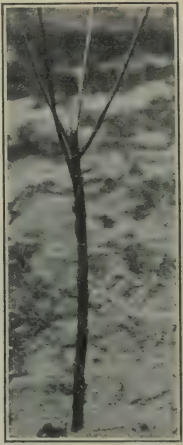

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FIG. 6.—A 2-year-old sour-cherry tree soon after it was planted. It represents one of the larger grades. The top has been shaped with a view to following the open-center method of pruning. (Michigan, May 11, 1915.)

The method most widely used is where the top is formed of several main frame or scaffold branches. This method properly fol-

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[1] Suggestions as to the details of planting trees in semiarid regions may be found in Farmers' Bulletin 727, U. S. Department of Agriculture. (Gould, H. P., and Grace, O. J. Growing fruit for home use in the Great Plains area, 39 p., 25 fig. 1916.)

lowed produces a tree with an "open center." The other or "central-leader" method of forming the tree is used by most growers in Door County, Wis. The manner of shaping trees when they are planted in accordance with these two methods or ideals is shown in figure 5.

The open-center method of shaping a tree at the time it is planted is further illustrated in figure 6, which shows a large-sized 2-year-old tree shortly after planting but before growth had started. The four branches which are symmetrically placed have been retained to form the peramnent head, the central stem of the tree has been removed, and the limbs which thus form the framework of the top have been headed back somewhat. As received from the nursery, this tree was headed about 3 feet high. This is too high to suit many growers, though it probably represents an average 2-year-old tree of large-sized grade handled by most nurseries. In planting 1-year-old cherry trees, growers in many cases head them at not more than 18 to 24 inches in height.

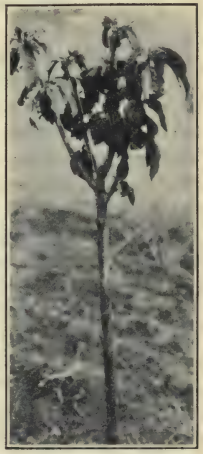

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FIG. 7.—A sweet-cherry tree of the Schmidt variety. It was planted as a 2-year-old in the spring of 1915 and shaped at that time with a view to its being pruned subsequently as an open-center tree. (Michigan, July 8, 1915.)

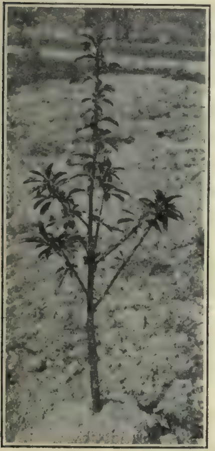

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FIG. 8.—A sour-cherry tree planted in the spring of 1915 and shaped as a central-leader tree. The principal difference between this tree and the one shown in figure 6 is the presence of the central axis of the tree which extends above the side branches. (Wisconsin, July 13, 1915.)

Figure 7 represents a sweet-cherry tree during its first season's growth. It was 2 years old when planted, and the top was formed for an open center.

Figure 8 shows a sour-cherry tree formed with a central leader when planted, now in its first season's growth. It is to be observed that the central branch or axis of the tree was not removed, as in the case of the tree in figure 6. The top otherwise is formed much the same as in the method first described. If the central leader should be removed at the topmost branch, it would make a fairly ideal tree of the open-center type, with the framework consisting of six main branches.

TILLAGE AND MAINTENANCE OF SOIL FERTILITY.

Tillage refers to the work done with the plow, harrow, cultivator, or such other implements as may be used in working the soil after the trees are planted. The word "cultivation" is commonly used in the same sense.

As a rule, commercial cherry orchards are given clean tillage during the growing season, or until about the middle of July. The principal exception to this practice is where an orchard in a high state of cultivation is seeded to clover or some other suitable crop and maintained for a season or two on a sod-mulch basis. There is a great difference, however, in clean tillage as practiced by different growers. The ideal of some requires that their orchard be cultivated twice a week during the active growing period of the trees; others are satisfied with three or four cultivations during the entire season.

The tillage of orchards can not be governed by arbitrary rules. In general it may be said that good tillage for a peach orchard would be likewise good tillage for a cherry orchard. The object is to conserve moisture by maintaining a finely pulverized surface mulch of soil until midseason. If the tillage which an orchard receives accomplishes this in full measure, other important results that have to do with the fertility of the soil will generally follow. Where the fruit is picked by the middle of July, at least one cultivation after the harvest may be desirable.

As cherries when grown on mahaleb stocks are rather shallow rooted, deep plowing should be avoided. Some growers prefer to use only harrows or cultivators unless the end in view, such as the turning under of a cover crop, can be accomplished only by plowing.

Cover crops are used extensively in most important cherry-producing sections. These are generally put in at the last cultivation, whether that occurs before or after the fruit is picked. Vetch and red clover are the leguminous crops most commonly used in cherry orchards. Soy beans have been tried in a few orchards in Michigan and New York with good results. Rye, buckwheat, rape, and cowhorn turnips are the most common nonleguminous cover crops, the first two being used the most extensively. Several of these crops, particularly vetch and buckwheat, are so handled each year by some growers as to mature sufficient seed for their cover-crop needs the following year. This practice in a number of instances has proved not only to be satisfactory so far as the orchard is concerned, but also to effect a considerable saving in the cost of seed where it is used in quite large quantities.

An inquiry often received at the United States Department of Agriculture is "What fertilizers are good for cherries?" To this question no specific answer can be made. In practice, cherry growers find that it pays to feed their trees fairly liberally. Many of them use commercial fertilizers in considerable quantities, but of various kinds and in different amounts, depending, if they are applied economically, upon experience that has indicated what foods are lacking in their soils.

As a rule, growers who have used stable manure systematically in their cherry orchards value it highly. Some apply it in large quantities, even buying it in car lots at more or less distant points.

The principles of tillage, the maintenance of soil fertility, including the use of cover crops and rates of seeding, and suggestions about the use of fertilizers are discussed more in detail in Farmers' Bulletin 631,[1] to which the reader is referred in the present connection.

INTERPLANTED CROPS.

A fruit grower naturally desires some return from the land occupied by an orchard during the nonproductive period of the trees, where it can be secured without detriment to them. The most satisfactory crops to interplant are those which need the same general tillage as the trees, which do not compete too heavily for moisture, and for which there is a good market. Beans, peas, tomatoes, and other vegetables of like cultural requirements are examples of the least objectionable crops. Corn is frequently used and is not seriously objectionable unless the greed of the grower impels him to plant it too close to the trees. Potatoes are doubtful, in some sections at least, since digging them in the autumn might be equivalent to a late cultivation, resulting in the stimulation of tree activities at an undesirable time.

All small grains are seriously objectionable, as they permit no tillage. Strawberries in bearing are not usually cultivated until after the fruit is picked. Their fruiting period is during the time when tillage is of the greatest importance to the cherry trees. Though raspberries and blackberries admit of and require much the same tillage as cherries, their demands upon the soil moisture are so great that fruit trees frequently suffer seriously in competition with them, and their use in orchards is not advised.

These comments will serve to suggest the general features which need to be considered in selecting a crop for interplanting in cherry orchards. However, it must be remembered that an interplanted crop at best is in the nature of a makeshift, the only legitimate excuse for it being the need of reducing the cost of developing the orchard to the bearing age. Though an orchard may endure an interplanted crop without appreciable ill effect, it is of no benefit to the trees unless the orchard receives better tillage than it would otherwise have. If the returns from the interplanted crop are sufficient to pay even approximately the cost of the tillage, the grower should regard himself as fortunate. The planting of an annual crop in an orchard is a system of double cropping, the more important crop being the trees. Though the tops require only a small part of the space above ground, the roots occupy a large portion of the soil much earlier in their lives than is commonly supposed.

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[1] U. S. Dept. Agr., Farmers' Bul. 631. (Gould, H. P. Growing peaches: Sites, propagation, planting, tillage, and maintenance of soil fertility, 24 p., 8 fig. 1915.) This bulletin will be sent without cost on application to the Secretary of Agriculture.

IRRIGATION.

As this bulletin relates primarily to the growing of cherries in humid sections where irrigation is not practiced, no special comments concerning this operation are required here. However, cherry interests of considerable importance have been developed in one or two irrigated districts. This applies particularly to centers of production in the Arkansas River valley in Colorado and to certain other localities in that State east of the mountains.

PRUNING.

There is probably no other operation in the production of fruit concerning which there are such wide differences of opinion and practice as prevail with regard to the pruning of trees. The fact that trees often produce abundantly and regularly under practically all systems of pruning or with no pruning whatever forces the conclusion that dogmatic statements and rule-of-thumb directions are unsafe and unwise.

The notion has been long prevalent that cherry trees should not be pruned, that the wounds made in cutting off limbs do not heal readily, and that the operation is detrimental to the success of the trees. A good many growers have developed their orchards in accordance with this conception. These theories, however, do not appear to be well founded.

While cherry trees may require less pruning than some other fruits, the ill effects of allowing the tops to become very dense and bushy have become apparent in numerous cases. The most obvious effects of neglecting pruning have been the diminishing size of the fruit as the trees have grown older and its unevenness in ripening. A number of cherry growers who have had this experience have thinned the tops of their trees, opening them well to the sunshine and air. Following this, the fruit has developed to a good size and the crop has ripened uniformly, so that all of it could be harvested at a single picking.

The pruning which a tree receives when planted and during the first two or three years thereafter has much to do with its future. Mistakes in forming the head or the results of neglect during the early years of its life are practically irreparable. On the other hand, if well formed and properly pruned during its first years the foundation for a good tree is established; subsequent errors in pruning, if they occur, may admit of correction without serious permanent harm to the tree.

The shaping of cherry trees at the time of planting has already been discussed. It is obvious that the two types of trees described—open center and central leader—must be treated quite differently in the subsequent pruning which they receive. These differences are outlined in the following paragraphs.

OPEN-CENTER TYPE.

SOUR-CHERRY TREES.

Figure 6 shows a sour-cherry tree shaped when planted to be grown as an open-center tree. During the first season after planting, two or three secondary branches usually develop from each of the limbs that comprise the framework of the tree. In pruning, the predominating idea should be the development of a strong, stocky tree, with a well-balanced, symmetrical head, which shall be sufficiently open to admit air and sunlight to every branch. Thus pruned, the development along the branches of a goodly number of strong, thrifty fruit spurs as the tree attains bearing age is favored.

Following the first season's growth after planting, some thinning out of the branches that developed during that season will usually be required. Two secondary branches are enough, as a rule, to leave on each main branch, unless others are needed to help make the tree symmetrical. Some heading back of the growth made that season is also advised, though some growers are opposed to cutting back at all. It is believed, however, that heading back the annual growth to some extent during the first two or three years after the trees are planted will result in a more stocky tree and one better formed for supporting heavy crops of fruit in later years than where the limbs are not headed back. The amount of heading back should depend upon the growth made the previous year. Where it is strong growers frequently cut back the limbs one-half or two-thirds of their length.

The annual pruning of sour-cherry trees until they come into bearing need not be materially different from that which follows the first season's growth in the orchard, as already described. The tops should always be kept open and the growth of the preceding season headed back more or less for two or three years at least. Comparatively little cutting back, however, is required after the trees reach the age of 3 or 4 years, which is about the age at which most sour varieties come into bearing, though this time varies with the variety, location, and treatment.

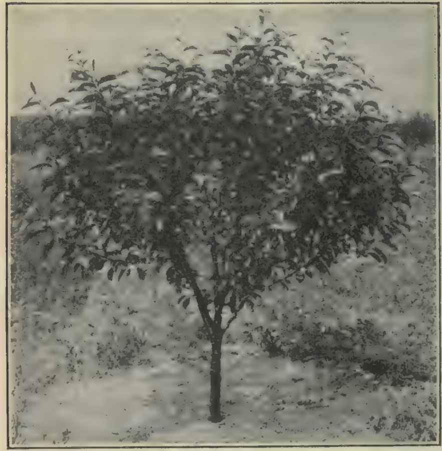

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FIG. 9.—A Montmorency cherry tree in its third season's growth from planting, pruned to an open center. (Michigan, July 9, 1915.)

Figure 9, which shows a Montmorency tree in July of its third season's growth in the orchard, further illustrates the pruning of young trees. It was planted as a 2-year-old tree, which was headed sufficiently low in the nursery to permit forming the permanent head at a height of 18 to 24 inches, which is satisfactory in this respect. The branches were reduced to five or six in number when it was planted, those allowed to remain being symmetrically arranged about the trunk. They were also headed back rather heavily to outside buds, thus giving the tree a fairly spreading habit of growth. Following the first season's growth after planting, the branches were again headed back quite heavily. The only pruning following the second season's growth (which was the year prior to that shown in the illustration) consisted of cutting out the interfering branches and such other limbs as were necessary to keep the top fairly open.

Figure 10 shows a row of Montmorency trees in their sixth season's growth from planting. These trees are in the same orchard as the one shown in figure 9 and have been handled in the same manner. The trees were headed back quite heavily following the first season's growth. No further heading back has been done, though the cross branches have been removed annually and the tops kept well open to the sunlight and air. The main branches of the trees possibly would have grown more stocky had they been lightly headed back once or twice more before they were permitted to elongate in an indeterminate manner.

In figure 11 is shown a sour-cherry orchard, probably 15 or 16 years old, that has been fairly well pruned and the tops kept well thinned of superfluous growth. The main branches have been headed back recently, to prevent the trees from becoming taller. The heads of these trees, however, are so high that very little of the fruit can be gathered without using ladders. In contrast, a very considerable proportion of the fruit can be gathered from the trees shown in figure 12 while the picker is standing on the ground. And further, the trunks of low-headed trees are better protected from sun scald, which is rather serious in some sections.

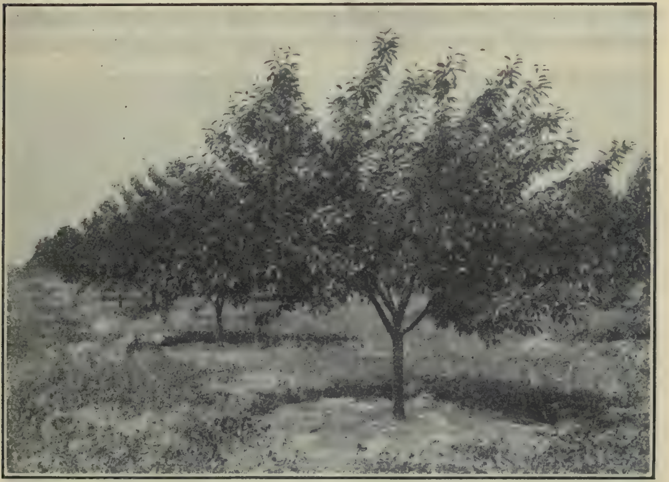
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FIG. 10.—A row of Montmorency cherry trees in their sixth season's growth from planting. These trees were pruned to open centers when set out and are in the same orchard as the one shown in figure 9. The orchard, which is now in clover, had received clean cultivation prior to this season. (Michigan, July 9, 1915.)

SWEET-CHERRY TREES.

The growing of sweet cherries is confined largely to sections where the open-center type of tree prevails, and if any attention is given to pruning, the trees are usually developed on that plan.

The pruning of 1 and 2 year old sweet-cherry trees when planted is shown, respectively, in figures 5 (*F*) and 7. A sweet-cherry tree in its second season's growth after planting is shown in figure 13. This tree was not headed back following its first season's growth. The photograph from which this illustration is made was taken on May 12, before the second season's growth was far advanced. Doubtless some secondary branches developed later in the season, but it may be assumed that they put forth near the ends of the branches as they appear in the illustration.

If the tree is allowed to grow each season with no heading back of the previous season's growth, a tree not unlike the one shown in figure 14 may be expected to develop. There is no evidence of the branches having been headed in at any time. New branches, developing each season, have put forth from buds near the ends of the previous season's growth. As a result, the branches are long, slender, and poorly adapted for supporting a fruit crop. While the development of an open-headed type of tree should be the aim in pruning, this one is much more open than is necessary for the ends in view.

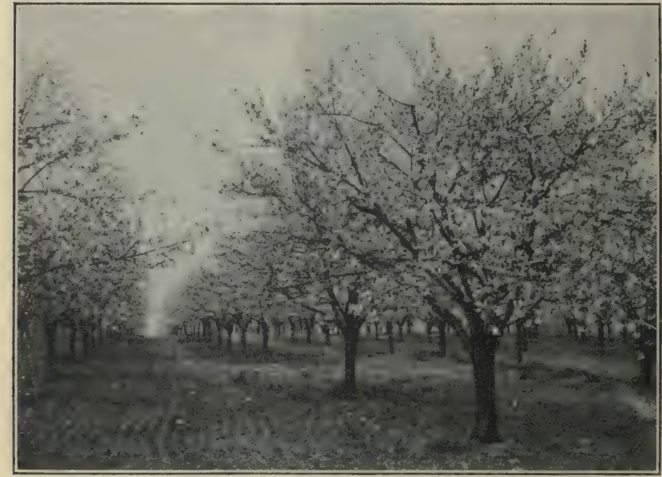

FIG. 11.—A sour-cherry orchard of mature age, 15 or 16 years old. The trees have been pruned to open centers. The main limbs have recently been cut back to prevent the trees from becoming taller. (New York, May 6, 1915.)

Most sweet varieties begin to bear by the time they are 6 to 8 years old. Up to this time they should be so managed that the limbs will become strong and stocky, and the tops should be kept sufficiently open to admit light and sunshine to every part of the tree where fruit spurs normally form.

The tree shown in figure 15 may be contrasted with the one in figure 13. The former is a Schmidt tree in July of its third season's growth; the latter a Windsor tree in May of its second season's growth. These two trees are not altogether comparable, as one is a year older than the other and being different varieties there may be differences in their habits of growth. However, the contrast shows an essential feature of heading back. The tree in figure 15 is stocky and strong. Last season's growth was headed back somewhat, and the secondary branches are developing at such points as to prevent the formation of the long, slender sections between branches that appear in figure 13.

Figure 14 may be contrasted with figure 16 to show still further the desirability of judicious heading back from year to year. The latter shows a Windsor tree 13 years old that has been systematically and regularly pruned. It has recently been topped, to prevent it from growing taller. The pruning given during its earlier years has resulted in a compact, strong tree, with a large bearing surface, yet the top is not so dense as to shade the fruit unduly.

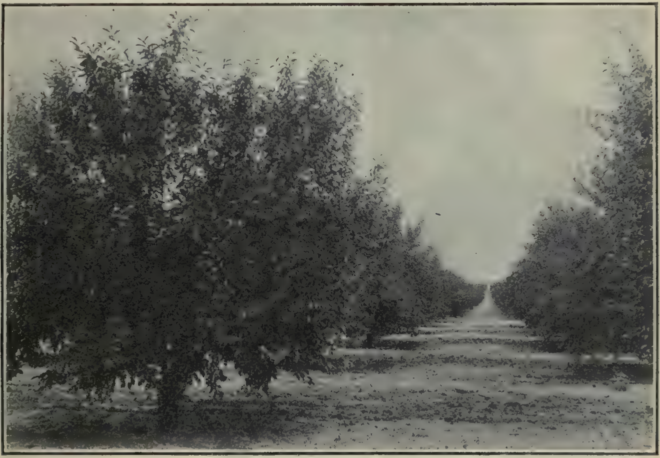

FIG. 12.—A Montmorency cherry orchard, showing low-headed open-center trees. Much of the fruit can be picked without using ladders. This orchard is irrigated as occasion requires. (Colorado, August 12, 1910.)

DUKE CHERRY TREES.

The habit of growth of the "Duke" cherries is more or less intermediate between the sweet and sour sorts, some varieties more closely resembling the former and others the latter. As the "Dukes" are planted largely in those sections where the open-center type of pruning is practiced, it follows that most of the trees of this class are pruned according to that system. Well-formed trees of the Late Duke variety of different ages are shown in figures 17 and 18. This variety resembles the sweet cherry in habit of growth rather than the sour cherry. 605
U5 age

The details of heading back and the extent of the annual pruning at the different ages, as well as other points in pruning, are features that call for good judgment, and that is largely a matter of experience.

CENTRAL-LEADER TYPE.

The central-leader type of tree is represented in practice by two general forms in which the difference depends upon whether the central limb is allowed to grow, or "lead," indefinitely or whether it is headed back at some point. The pruning of a central-leader tree when planted is shown in figures 5 (*D*) and 8. If the central branch is headed back somewhat when the tree is planted, it may be expected to develop as shown in figure 19. Numerous branches have grown from buds along the leader, and the place of the latter has been taken in a measure by a younger branch that developed from a bud near its top.

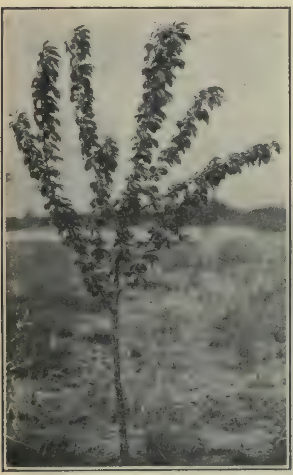
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Fig. 13.—A sweet-cherry tree of the Windsor variety early in its second season's growth from planting. It has not been well headed in. (Michigan, May 12, 1915.)

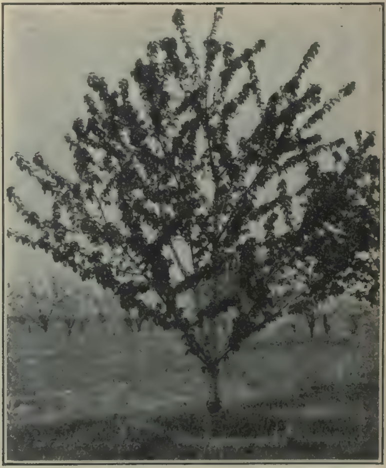
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Fig. 14.—A sweet-cherry tree of the Windsor variety 7 years old which has received little or no pruning since it was planted. (Michigan, May 12, 1915.)

Figure 20 shows a tree planted as a 1-year-old that is now in its second season's growth. The central leader was not cut back, and it has continued to elongate from the terminal bud. The side branches were headed in but little or none at all. Figure 21 shows the same tree after it had been pruned by the owner. The pruning consisted in thinning out the branches without any heading in. The central leader is clearly shown as a continuous stem throughout the entire height of the tree. Its upward extension can be checked at any time by simply heading it back. If this is done a tree similar to the one in figure 19 will result; but if the heading back is not done and if systematic pruning is neglected, an undesirable form, like the one in figure 22, may be expected. This tree is so tall that thorough spraying is difficult, picking the fruit is expensive, and it is not well shaped to sustain the weight of a good crop of fruit.

The annual pruning of a tree shaped with a central leader should consist of thinning out the branches, in order to keep the top open, and of such heading back as may suit the ideals of the grower.

The choice of these two types of trees—open center and central leader—is largely a matter of personal preference. It is claimed that a tree with a central leader will withstand storms and winds better than an open-center tree, but growers are not unanimous in this opinion.

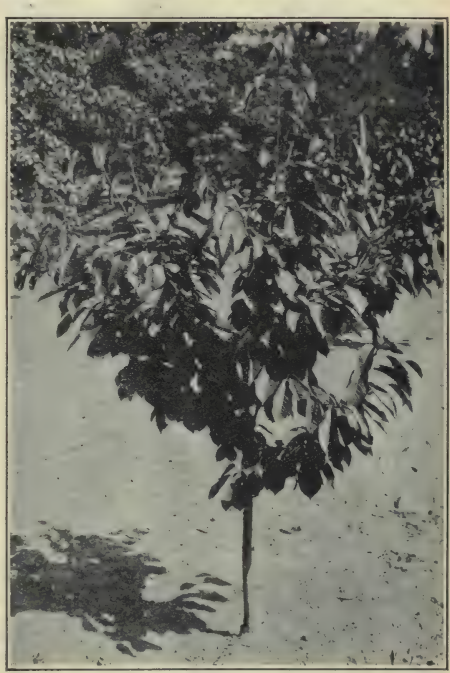

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FIG. 15.—A sweet-cherry tree of the Schmidt variety in its third season's growth from planting. The branches have been headed back with a view to developing strong, stocky limbs. (Michigan, July 10, 1915.)

FUNGOUS DISEASES AND INSECTS AND OTHER PESTS.

Cherries are subject to a number of insect pests and fungous diseases that occur more or less commonly in most regions. The timely and systematic use of insecticides and fungicides will usually prevent serious loss. Some varieties of sweet cherries crack badly, however, if weather conditions are unfavorable, and when cracking does occur it is difficult or even impossible to prevent losses from decay.

Among the commoner insects of economic importance in cherry growing may be mentioned the cherry aphis, curculio, and slug. The San Jose scale often attacks sweet-cherry trees, but rarely occurs so abundantly on sour varieties as to require spraying. Brown-rot on the fruit and shot-hole fungus on the foliage are perhaps the most widespread and destructive diseases. Other insects and diseases occur to some extent, but as a rule they are less serious than the ones named and usually can be controlled by the same applications of spray mixtures that are made for the more important troubles. Combination sprays can be used in combating most insects and diseases. The spraying program widely followed calls for at least three applications as follows:

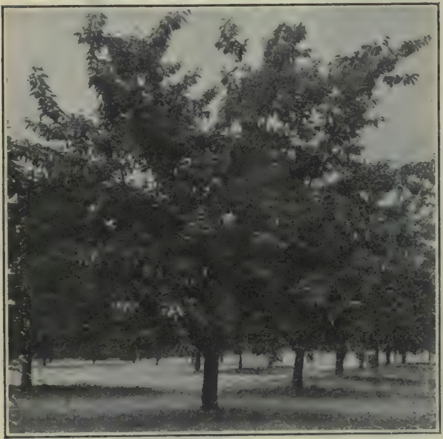
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FIG. 16.—A sweet-cherry tree of the Windsor variety 13 years old that has been systematically pruned from year to year. (New York, June 30, 1915.)

(1) During the cluster-bud stage before the blossoms open.

(2) After the fruit has set and the dried-up parts of the blossoms have fallen off.

(3) About two weeks after the second application.

These applications are usually sufficient for sour varieties before the fruit is picked. One or two additional applications are made sometimes to sweet varieties, in order to guard as far as possible against loss from brown-rot. Many growers spray all varieties at least once after the fruit is picked.

Birds exact rather heavy toll at times, especially from small orchards. The loss from large orchards is probably negligible in comparison with the relative economic value of the birds that eat the fruit. Various means of protecting the fruit from birds are used.

Small trees in yards or gardens are sometimes covered with mosquito netting. The hanging of bright pieces of tin in the tree so that they will move freely in the wind has also been recommended. Mulberry trees are sometimes planted in close proximity to cherry orchards. Birds seem to prefer the fruit of the mulberry to cherries, and where there is an abundance of the former the cherry is said rarely to be touched by them. June berries may also serve a similar purpose in sections where they grow well.

PICKING AND HANDLING THE FRUIT.

Only a brief account of the harvesting and handling of cherries can be given here, but reference to the methods in common use in some of the important districts will be of interest to those who are not familiar with these features of the cherry industry.

PICKING.

The manner in which cherries are picked is governed in a measure by the disposition to be made of them. Where they are to be shipped to a distant market the stems must be left on the fruit. If they are pulled off the juice will ooze from the fruit.

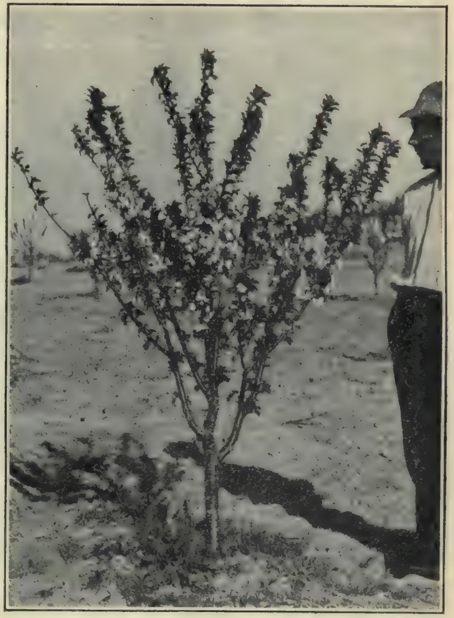

FIG. 17.—A Late Duke cherry tree 4 years old, pruned to an open center. (Michigan, May 12, 1915.)

When harvested with the stems on, the picker carefully grasps at one time the stems of several fruits in a clister and strips them from the tree by giving a slightly backward pull. If due care is exercised the stems will remain firmly attached to the fruit and the spurs will not be broken or otherwise injured. In one important cherry-growing region the common method of removing the cherries is by clipping the stems with scissors or shears. When pickers become accustomed to using shears, they usually object to doing it in any other way, though probably it is not quite so rapid a method as stripping the fruit by hand.

If the fruit goes to a cannery located in the immediate vicinity of the orchard it is commonly pulled from the stem. Canners usually pay more for fruit picked in this way than for that which retains the stems. They are saved the expense of stemming after the fruit reaches the cannery, and a given bulk of cherries without stems contains an appreciably larger quantity of actual fruit than an equal bulk with stems. Fruit gathered by clipping the stems, however, is not desired by commercial canners, as the portion of the stem that remains on the fruit is too short to be removed by the mechanical stemmers commonly used.

Comparatively small receptacles are used by pickers when harvesting cherries. The handling of cherries in an orchard where the fruit is taken at once to a near-by cannery is shown in figure 23. Here the fruit is pulled from the stems. The picking pails in this case hold 5 quarts. The fruit is emptied from the pails into lug boxes, in which it is hauled to the cannery. In some instances 5 or 8 pound baskets are used also for picking, while other types of pails, baskets, or similar receptacles of 4 to 6 quarts' capacity are not uncommon among the average picking gang.

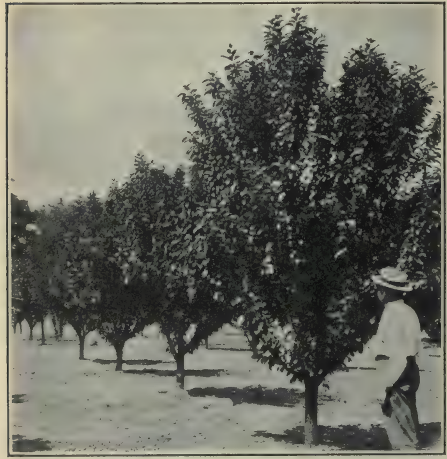
P16690HP

FIG. 18.—Late Duke cherry trees 8 years old. The open-center type of pruning has been followed, but on account of the very upright habit of growth and the heavy foliage the individual branches are not visible. (Michigan, July 10, 1915.)

The pickers commonly attach the picking receptacles to themselves by passing a belt through the bails or handles, as may be seen in the case of the picker on the left in figure 24. Frequently, also, a hook is placed on the handle, thus making it convenient to hang the pail or basket on a limb or a rung of the ladder.

Under good crop and tree conditions an average picker will harvest 150 to 200 pounds of fruit, or about 3 to 4 bushels, in a 10-hour day. Exceptionally rapid pickers sometimes harvest as many as 400 pounds in a day.

Where the trees are headed low a good deal of the fruit can be picked without climbing, but to reach the fruit on the higher limbs stepladders or straight ladders are used, as shown in figures 24 and 25.

Picking is paid for usually by the pound or quart; sometimes by the gallon, case, or crate. In nearly all commercial orchards picking is piecework rather than daywork, and the prevailing rate is 1 cent a pound or 25 cents a crate of 16 quarts.

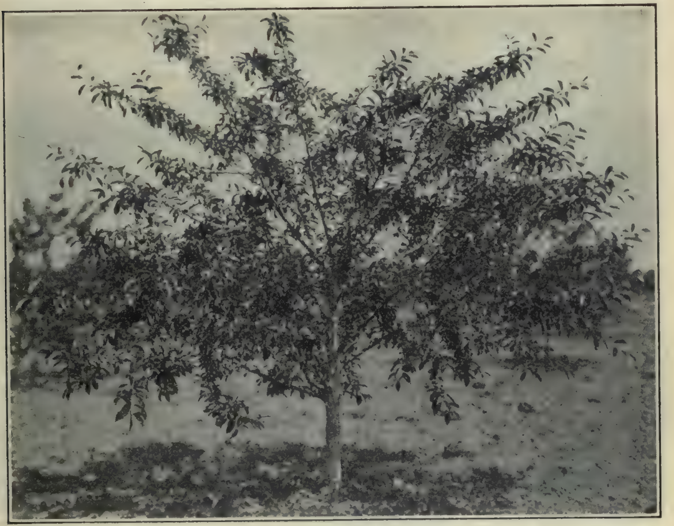

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Fig. 19.—A Richmond cherry tree in its sixth season from planting, pruned when set out to a central leader of determinate growth. In time the central leader will largely disappear, and the top will be composed of branches of about equal size and importance. (Wisconsin, July 13, 1915.)

The assembling of an adequate number of pickers is a critical feature in the proper handling of a crop of cherries. The fruit should not be picked until it is ripe. When this stage is reached it should be moved very promptly; otherwise it will deteriorate. Under favorable conditions the period of durability of ripe fruit on the trees of the more important varieties is rarely more than five or six days. In orchards where the fruit is ripening uniformly so that the trees can be stripped at one picking if desirable, a force of 8 to 12 pickers to the acre is not unusual.

It is not always an easy matter to decide just when cherries should be picked. The tendency is to pick as soon as they are slightly colored and before they are fully ripe. The fruits usually increase quite rapidly both in size and weight during the last two or three days before full ripeness is reached. Instances are reported of an increase in weight of 10 per cent by delaying picking for two days. Better flavor and quality are also secured by allowing the fruit to remain on the tree as long as consistent with the use to be made of it.

Various methods of handling the fruit after it is picked are followed by different growers. It may be packed in the orchard, as shown in figure 26, where baskets are used. In some sections a movable packing house is provided, a common type of which is seen in figure 27. This house is built on runners, so that it may be moved readily from place to place by a team. In this case, the fruit is placed by the pickers in veneer boxes holding 1 quart, and the boxes are packed in the 16-quart cases, or crates, seen at the right in figure 27.

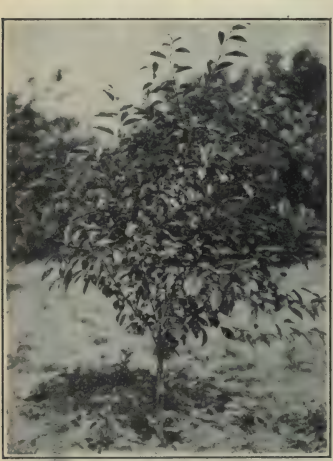

FIG. 20.—A Richmond cherry tree in its second season's growth from planting, pruned when set out to a central leader of indeterminate growth. The side branches were headed back but little or not at all. (Wisconsin, July 14, 1915.)

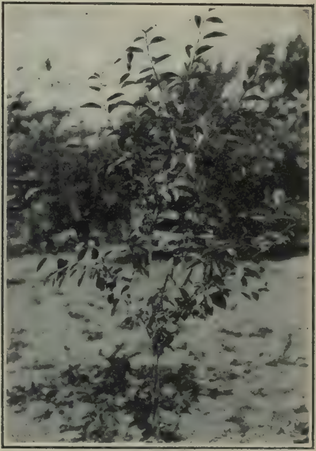

FIG. 21.—The same Richmond cherry tree shown in figure 20 after it was pruned by the owner. The pruning consisted entirely of thinning out the branches. No cutting back was done. (Wisconsin, July 14, 1915.)

In some cases where a grower puts up a fancy pack, it is necessary to sort and hand pack carefully every box or basket. A convenient table for such work as shown in figure 28. Because of the tender character of the fruit, only a relatively small quantity should be placed on a packing table at any one time. A table the size of the one here shown is large enough for two packers, one on either side.

PACKAGES AND PACKING.

Several different styles of packages are used in different sections. Perhaps the 16-quart case shown in figure 27 is used for shipping larger quantities of cherries than any other one style. In some sections 24-quart or 32-quart crates, similar to those shown in figure 29, are preferred. All of these styles of packages are extensively used for shipping strawberries. Baskets holding 6 or 8 pounds prevail in other sections. . A few growers pack sweet cherries in 10-pound flats, similar to those that are commonly used in California for a similar purpose.

COMMENTS ON VARIETIES.

Unlike the other widely grown deciduous-tree fruits, the bulk of the commercial cherry crop is made up of a small number of varieties. Even if all the varieties of minor importance are considered the number is still small when compared with such fruits as apples and peaches. It follows that the few really important varieties are very widely grown.

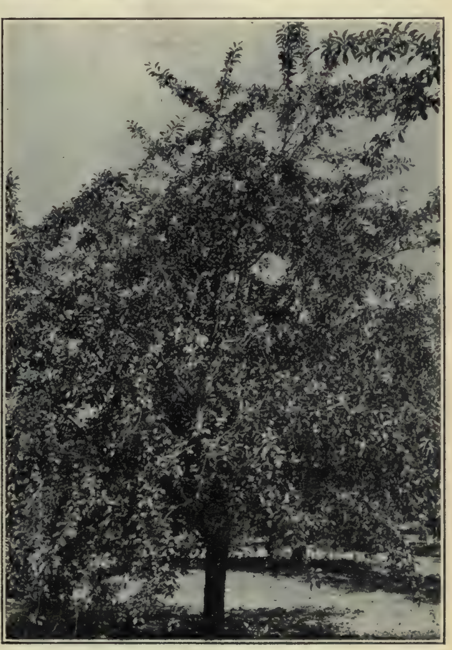

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FIG. 22.—A Richmond cherry tree 18 years old. This tree evidently was pruned to a central leader when it was planted and has not received much attention as to pruning since. (Wisconsin, July 13, 1915.)

The sour varieties of primary importance east of the Rocky Mountains are the Richmond (*Early Richmond*), Montmorency (*Montmorency Ordinaire*), and English Morello (*Wragg*). Those of secondary importance can not be given as definitely, but Dyehouse, Large Montmorency, and Ostheim are representative sorts.

The sweet varieties of first importance east of the Rocky Mountains are the Tartarian (*Black Tartarian*), Windsor, Schmidt

(*Schmidt's Bigarreau*), Napoleon (*Royal Ann*), and Spanish (*Yellow Spanish*). As in the case of the sour varieties, the number of sweet sorts of secondary importance is rather indefinite. Early Purple, Knight (*Knight's Early*), Rockport, Wood (*Governor Wood*), and Elton occur more or less frequently.

Of the Duke varieties, May Duke, Late Duke, and Philippe (*Louis Philippe*) are among those most commonly found.

Technical descriptions of varieties are unnecessary here, but the characteristics of the more important varieties are given below.

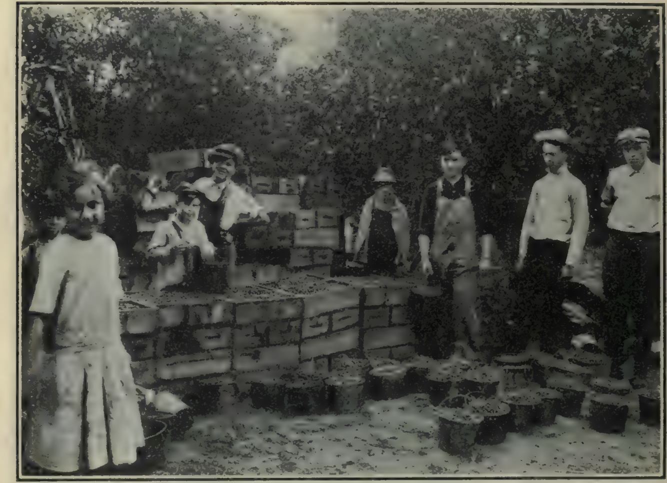

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FIG. 23.—Picking Richmond cherries. From this orchard the fruit goes direct to a near-by cannery; hence, the fruit is harvested without stems. The pails in the foreground hold 5 quarts each. Tight receptacles give protection to the pickers against the juice that oozes from the wounds made in pulling off the stems. (Ohio, July 2, 1915.)

SOUR VARIETIES.

Richmond (*Early Richmond*).—The importance of the Richmond cherry is due primarily to its relative season of ripening, which is about 7 to 10 days earlier than the Montmorency; also because of its hardiness. It is the most extensively planted sour cherry of its season. The Dyehouse, which ripens at approximately the same time, is found in only a comparatively few orchards.

Montmorency (*Montmorency Ordinaire*).—This is by far the most extensively planted sour cherry, being preferred by the canners to other varieties. Were it not for lengthening the cherry season, there would be little reason for planting any of the other sour varieties now available. The tree is not considered as hardy as the Richmond, sometimes suffering winter injury when the Richmond is uninjured. In sequence of ripening the Montmorency is midseason. In the more important sour-cherry growing sections the bulk of the crop is harvested between about July 10 and 25, with naturally more or less seasonal and regional variation from these dates. There are a number of varieties in what is sometimes called the Montmorency group, and a good deal of confusion exists in regard to their identity. The varietal characters are so minute and their resemblance to eacth other is so close that it is exceedingly difficult to distinguish the different sorts in this group with absolute certainty.

English Morello (*Wragg*).—This variety fills much the same place in the cherry industry as a late sort that the Richmond holds as an early variety. It is the principal sour variety planted to follow the Montmorency in sequence of ripening. However, it does not appear to have as wide a range southward in its adaptation as the Richmond and Montmorency. The name "Wragg" is commonly considered a synonym of English Morello, but in a few sections under the name "Wragg" the variety is much more largely planted than any other sort. In those sections the conviction prevails that there are differences which clearly distinguish it from the English Morello. The Wragg tree is said to be smaller and more productive than the English Morello and the fruit somewhat later in ripening and more acid in flavor. In other sections growers fail to see any differences between them. It is quite possible that more than one variety or strain is grown under the name "Wragg."

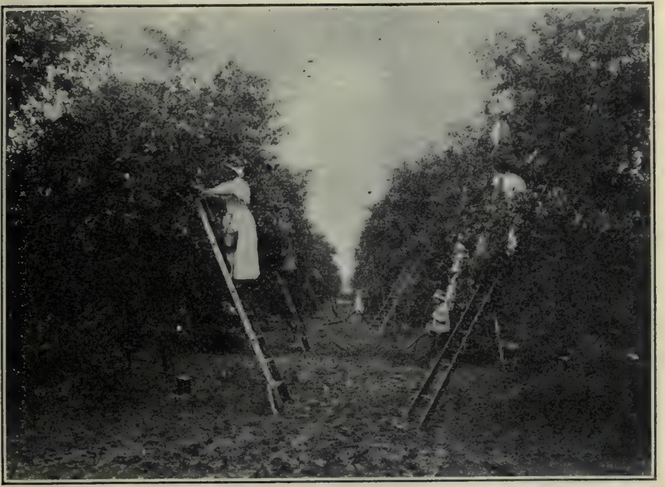

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FIG. 24.—Picking Richmond cherries. The type of stepladder here seen is commonly used in picking cherries. (Ohio, July 2, 1915.)

The English Morello trees are smaller than either the Richmond or Montmorency; the branches are slender and willowy with a decidedly drooping habit of growth. The foliage is very susceptible to the shot-hole fungus. Unless carefully sprayed the leaves in many cases nearly all drop in midsummer from the effects of this disease. The tree comes into bearing earlier than most sour varieties.

SWEET VARIETIES.

Tartarian (*Black Tartarian*).—This variety is one of the most widely grown of the sweet sorts. The tree thrives under a wider range of soil and other conditions than most sweet cherries. The fruit is small, relatively, and not as firm as some of the other sweet sorts; but for home use it is an important variety. It is less productive than many other sweet varieties. The color of the fruit is dark purplish black.

Windsor.—On the basis of the quantity of fruit produced, this variety is probably the most important midseason sweet cherry. The tree is relatively hardy and productive, though rather slow in coming into bearing. The fruit is firm and ships well. While not as good in dessert quality as the Tartarian, it is a popular market sort in the sections where it is grown. It ripens, as a rule, about with the Montmorency, though it varies from slightly earlier in some cases to a few days later. The color is very dark red, becoming nearly black.

Schmidt (*Schmidt's Bigarreau.*) — In some sections this variety is now attracting considerable attention, which seems to be well merited. The tree has many desirable characteristics, and the fruit has the qualities of a good market cherry. It is also one of the sweet varieties most resistant to brown-rot. Though quite widely distributed in the sections where sweet cherries are grown, it is not being produced in large quantities. In season it is slightly earlier than the Windsor. The color is puprlish black.

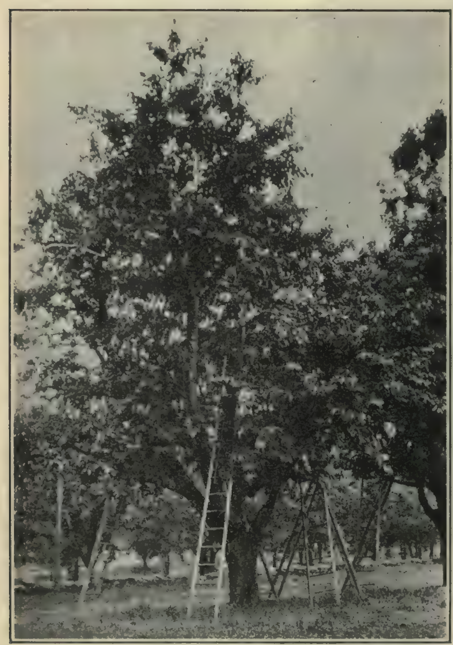

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FIG. 25.—A Wood (*Governor Wood*) cherry tree 35 or 40 yeras old. Its height is indicated by the ladders, which are 20 feet long. Sometimes an old tree that is very tall can be improved by topping it back heavily. (New York, June 23, 1915.)

Napoleon (*Royal Ann*).—This is doubtless the most important light-colored sweet cherry, not only in the cherry-growing sections in the portion of the country under consideration, but also in the cherry-producing sections of the Pacific Coast States, where it is usually known by its synonym *Royal Ann.* The tree is more sensitive to soil and other conditions than many varieties, and the fruit is very apt to crack before it is ripe unless the weather is rather dry. It is also susceptible to brown-rot; but there seems to be no other light-colored midseason sweet cherry to take its place. The color is varying shades of bright red over a yellowish background.

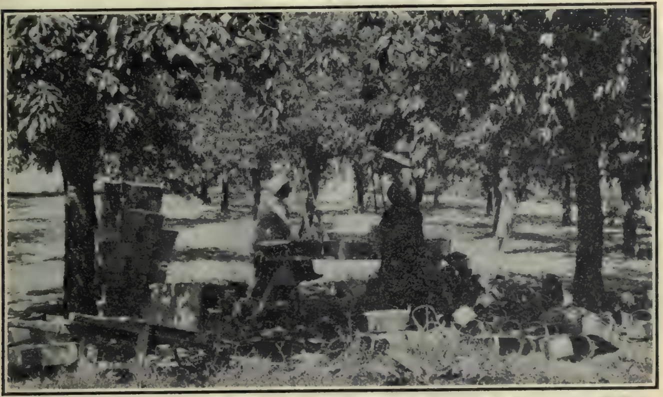

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FIG. 26.—Packing Tartarian cherries in climax baskets. (New York, June 28, 1915.)

Spanish (*Yellow Spanish*).—This cherry has long been one of the most widely grown of all the sweet varieties, though it is now produced much less extensively than the Napoleon. It comes into bearing younger than many of the other sweet sorts. Heavy losses of fruit from brown-rot sometimes occur. In season it is a few days earlier than the Napoleon. The color is bright amber yellow, with a reddish blush, slightly mottled.

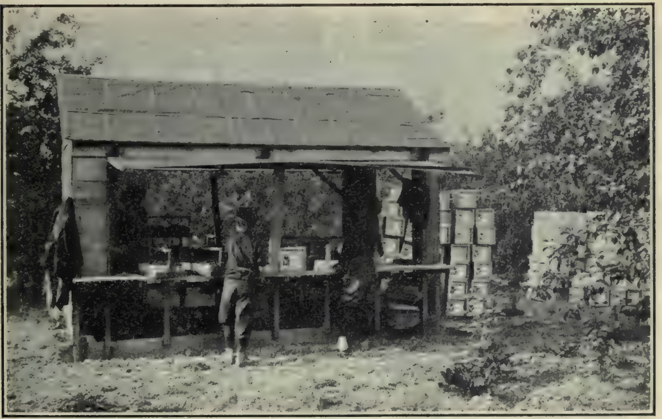

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FIG. 27.—A movable type of packing house used in handling cherries. The 16-quart case, of which one style is shown here, is a popular package in some sections. (Wisconsin, July 13, 1915.)

DUKE VARIETIES.

May Duke.—This variety is one of the most widely grown of any in its group and has many points of merit, especially for home use and local markets. It ripens its fruit over a long period, a characteristic that is decidedly objectionable for a commercial variety. The tree is quite hardy and adapts itself to a wide range of soil conditions. In habit of growth it is upright, somewhat intermediate between the sweet and sour tree types.

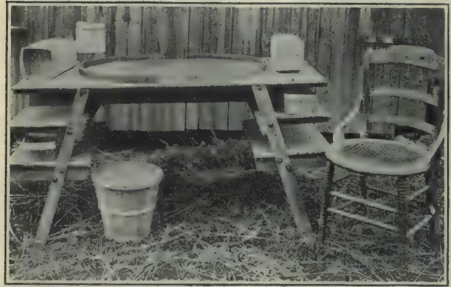

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FIG. 28.—A packing table of convenient design for use where very careful sorting and grading are required. (New York, June 23, 1915.)

Late Duke. — The chief value of the Late Duke is, perhaps, its late season of ripening, which is two to four weeks after the May Duke. It is suitable for home use and local markets rather than for long-distance shipping.

Philippe (*Louis Philippe*).—This variety in its tree characters resembles the sour cherry much more closely than it does the sweet cherry. It is a good, vigorous tree with healthy foliage. The fruit has many points of merit, as well as the tree. But, unfortunately, most growers report it to be entirely too unproductive for commercial purposes. If it were as productive as the Montmorency, or even some of the other sour sorts, it would be a valuable cherry. The tree is said to be faulty in that the branches split down easily, much more so than most other varieties.

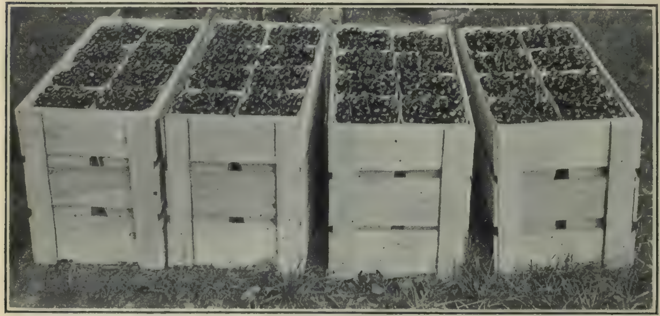

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FIG. 29.—Cherries packed in 32-quart crates for shipment to market. (New York, June 22, 1915.)

THE STERILITY OF SWEET CHERRIES.

In some parts of the Northwest where sweet cherries are grown extensively it has been shown[1] that practically all varieties planted in that section are self-sterile or nearly so. This characteristic, if it occurs among sweet cherries east of the Rocky Mountains, does not appear to be a serious factor, since they are planted usually where cross-pollination doubtless occurs freely.

There may be cases of unproductiveness, however, that admit of being explained by the absence of suitable varieties for cross-pollination. Sour cherries are commonly assumed to be fertile with their own pollen.

THE SEQUENCE OF RIPENING OF DIFFERENT VARIETIES.

The cherry season is relatively short, and it is important that the varieties which a grower may plant shall ripen in such a sequence that he can both pick the fruit and market it to the best possible advantage.

The following list of varieties includes those of the most commercial importance and a considerable number of others that are grown more or less commonly in small lots or in home orchards. They are named as nearly as possible in the order in which they ripen.

LIST OF VARIETIES, NAMED IN THEIR APPROXIMATE ORDER OF RIPENING.

[The number in parentheses following each variety signifies (1) a sour variety, (2) a sweet variety, and (3) a Duke variety.]

1. **Early Purple (2).**
2. **May Duke (3).**
3. **Coe (*Coe's Transparent*) (2).**
4. **Rockport (2).**
5. **Eugenie (*Empress Eugenie*) (3).**
6. **Kirtland (2).**
7. **Dyehouse (1).**
8. **Wood (*Governor Wood*) (2).**
9. **Richmond (*Early Richmond*) (1).**
10. **Tartarian (*Black Tartarian*) (2).**
11. **Philippine (*Louis Philippe*) (3).**
12. **Olivet (3).**
13. **Eagle (*Black Eagle*) (2).**
14. **Late Duke (3).**
15. **Spanish (*Yellow Spanish*) (2).**
16. **Napoleon (*Royal Ann*) (2).**
17. **Schmidt (*Schmidt's Bigarreau*) (2).**
18. **Elkhorn (2).**
19. **Windsor (2).**
20. **Ostheim (1).**
21. **Montmorency (1).**
22. **Large Montmorency (1).**
23. **Dikeman[1] (2).**
24. **Bessarabian (1).**
25. **English Morello (*Wragg*)[3] (1).**
26. **Lotuvka (1).**
27. **Brusseler Braune (1).**
28. **Magnifique (*Belle Magnifique*) (3).**

The order in which the names are listed indicates the sequence in which they ripen, as nearly as it is possible to determine it from available data, though the sequence of ripening varies more or less in different years, even in the same orchard, as well as in different orchards; for instance, some growers report the Windsor as earlier, others as later, than the Montmorency. This variation should be kept in mind when making comparisons with this list.

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[1] Gardner, V. R. A preliminary report on the pollination of the sweet cherry. Oreg. Agr. Sta. Bul. 116, 40 p., 12 pl. 1913.

[2] This variety should not be confused with the Dyckman cherry, which is rarely seen now, but in an earlier day was grown to a considerable extent about New York City. It ripens with Tartarian and has been considered by some as identical with that variety. The Dikeman is not much grown. Its principal value is its lateness in ripening. The name is sometimes incorrectly written Dykeman.

[3] See the comment concerning the identity of the English Morello and *Wragg* on pages 32–33.

THE FUTURE PLANTING OF CHERRIES.

The cherry, generally speaking, has been a profitable fruit to grow in the past. Largely, doubtless, because of this, the industry has been extended considerably in recent years. Increased plantings, particularly of sour cherries, have been made not only in sections where previously large quantities have been grown for market but also in regions not formerly prominent in this respect. It therefore follows that large numbers of trees are just coming into bearing or have not yet reached their full bearing capacity.

The most of the important commercial cherry-producing regions are so located geographically that much of the fruit from them finds its natural outlet through the same markets, thus making keen competition in seasons of a good crop in the several more important sections of commercial production. As the younger orchards, of which there are many, come into full bearing, competition naturally may be expected to increase rather than decrease, with its corresponding effect upon the prices received by the grower, unless there is an increase in consumption. This possibly may be brought about either by the cherry becoming more popular or by reaching markets not fully supplied through the usual channels of distribution.

The prospective cherry grower, therefore, will do well when seeking a location for an orchard to take fully into account the extent to which the demand for cherries is supplied in the markets that are within a convenient radius of any location that he may consider. Where one can locate, or is located, in a good cherry-growing section and within easy reach of a town not well supplied with cherries, it seems probable that an orchard of this fruit may be planted with reasonable prospects of profitable returns.

In fact, some orchards known to the writer, which are located in regions even where there are no large towns, are proving very satisfactory. These are regions in which little attention is being given to fruit growing, yet where there are possibilities in this direction. Enterprising farmers who have planted orchards, including other fruits as well as cherries, find a ready sale at good prices for their entire product among the people in the surrounding communities, who come to the orchards for their supplies, thus greatly simplifying the marketing problems so far as the growers are concerned.

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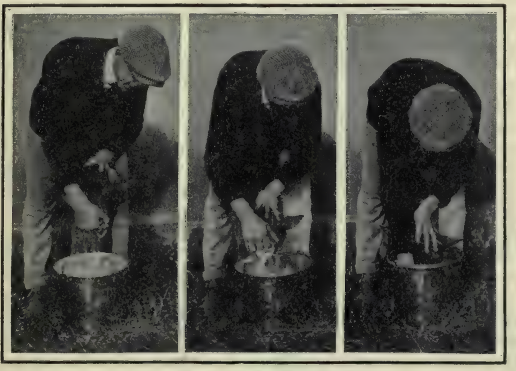
DATE DUE

FEEDING AND MANAGEMENT OF DAIRY CALVES AND YOUNG DAIRY STOCK

W. K. BRAINERD and H. P. DAVIS
Dairy Division



Teaching the Calf to Drink Milk

FARMERS' BULLETIN 777

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
A. D. MELVIN, Chief

Washington, D. C. February, 1917

FEEDING the cow well before calving insures a strong, healthy calf. The best time to wean the calf is after it takes the first milk. Early weaning makes it easier to teach the calf to drink.

Everything about the calf should be scrupulously clean.

Milk from infected cows or from a creamery should be pasteurized before it is fed.

Calves should be fed sweet milk of a uniform temperature and should always receive a little less than they desire.

All calves should be fed regularly; very young calves should be fed three times a day.

At first the calf is fed whole milk, the quantity being gradually increased. Skim milk is substituted as soon as practicable and if cheap is continued until the calf is six months old. Ordinarily the maximum quantity of skim milk that can be fed economically is 20 pounds a day. When the calf is 2 weeks old, grain and bright, clean hay should be offered; the quantity fed should be increased as the calf's appetite demands.

Milk substitutes are not equal to milk, but give fair results when used with care.

Quarters must be clean and dry, with plenty of bedding.

Stanchions save milk and prevent the calves from sucking one another.

Horns are more easily prevented than removed.

Water is necessary for calves.

Marks for identification should be plain without disfiguring the animal.

Calf diseases are largely the result of filth and carelessness. Prevention is cheapest and best.

Young dairy stock should have all the hay they will eat, and grain in proportion to weight.

The heifer should be bred to freshen when about 2 years old. Handling before freshening prevents shyness.

Fall calving usually gives best results.

The young bull should have an abundance of feed, plenty of exercise, and not be allowed too heavy service.

The foregoing points on feeding and management of the dairy calf are discussed somewhat fully in this bulletin.

FEEDING AND MANAGEMENT OF DAIRY CALVES AND YOUNG DAIRY STOCK.

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FEEDING AND MANAGEMENT OF THE DAIRY CALF.

FEEDING BEFORE BIRTH.

POORLY nourished cows give birth to weak, puny calves which are hard to raise. The feeding of the calf, therefore, begins before it is born. The food elements necessary for the development of the calf are taken into the stomach of the cow, digested, assimilated, and transmitted to the calf through the umbilical cord, the connection between the mother and the calf. It is evident that if the cow does not receive food enough to keep herself in thrifty condition and at the same time develop her calf, both she and the calf must suffer. In endeavoring to raise good, thrifty calves many dairymen handicap themselves at the start by not properly feeding the pregnant cows. Such cows should have an abundance of palatable and succulent or juicy feed in order to insure good body flesh and healthy, thrifty condition at calving time. The calves will then be well developed, strong, and sturdy, and ready to respond normally to proper feed and care.

SEPARATION FROM THE COW.

It is assumed that the calf is not to be raised by sucking the cow, but is to be fed by hand. The longer it sucks, therefore, the more difficult it will be to teach it to drink. On the other hand, the first (or colostrum) milk of the cow possesses properties which stimulate the calf's stomach and other digestive organs to action. Colostrum is nature's physic, and for this reason the young calf should always receive its mother's milk at first. The calf is sometimes weak at birth, and for this reason should have nourishment as soon as possible. It is usually easier to induce the calf to suck the cow than to try to make it drink from the pail. Because of these facts most dairymen prefer to let the calf remain with its mother for about 48 hours immediately after birth. An additional advantage of this practice is that the dam will carefully dry the calf by licking within the first few hours of its life. In the case of a weak calf or one that does not gain strength readily it may be best to allow it to remain longer than 48 hours, although under such circumstances it is sometimes difficult to teach the calf to drink, and serious trouble may result from its failure to obtain food.

TEACHING THE CALF TO DRINK.

It is desirable that the calf be in thrifty, vigorous condition when it is taught to drink. It should be kept without food for at least 12 hours, at the end of which time it will be hungry and will usually drink milk from the pail much more readily than when not hungry. Warm, fresh milk from the mother should be put into a clean pail and held near the floor, in front of the calf, which will generally begin to "nose" about the pail. Once it gets a taste of milk, it will usually drink without further trouble. Often, however, it is necessary for the attendant to put one or two fingers into the calf's mouth, drawing the hand down into the milk as the calf begins to suck the fingers. The calf in this way gets a taste of the milk and often begins to drink without further coaxing. If not, the process must be repeated. Sometimes, however, the calf can not be induced to drink in this way, and force has to be resorted to. In such case the feeder, facing the same direction as the calf, should straddle its neck and back the animal into a corner. The pail of milk should be held in one hand and the nose of the calf grasped with the other, two fingers being in its mouth. The nose of the calf is then forced into the milk, when it will usually begin to drink. (See illustration on title page.)

Sometimes a valuable calf, too weak at birth either to suck the cow or to drink from a pail, can be saved by feeding from a bottle, either with or without a nipple.

CLEANLINESS THE FIRST ESSENTIAL.

Cleanliness is absolutely essential to the successful raising of calves. This is equally necessary in feed, pens, bedding, and pails or utensils. All milk fed should be fresh and clean, and the same is true of other feeds. Calf pens should always be kept clean and be filled with plenty of dry bedding. Great care should be taken in washing the milk pails. These should be thoroughly scalded with boiling water, or sterilized with steam if possible. Discarded feed should be removed from the feed boxes, which should be thoroughly brushed and cleaned each day. Attention to these details is the best preventive of disease. Nearly all disorders or diseases of the calf are caused either directly or indirectly by lack of cleanliness.

Certain infections causing chronic diarrhea or scours, either contagious or otherwise, are discussed under the head of "Diseases," but there are many small disturbances of the calf's stomach and digestive system which hinder growth and development that are caused by bacteria. Filth and dirt are the natural breeding places of bacteria. Elimination of filth usually means freedom from disease.

PASTEURIZATION OF MILK.

Milk from cows infected with a communicable disease, such as tuberculosis, should always be pasteurized (heated to 145° F. and held at that temperature for 30 minutes) before it is fed to calves. When separated milk from a creamery is fed it should always be pasteurized, because it is practically impossible to know that such milk is free from infection.

QUANTITY AND QUALITY OF MILK.

The quantity of liquid feed that a calf needs depends upon the size and age of the calf and to some extent upon the kind and condition of the feed. At birth a 50-pound calf should have about 8 pounds a day, while a 100-pound one should have about 12 pounds. It is better to underfeed at the start than to overfeed. Many beginners make the mistake of letting the calf have all the milk it wants. This would probably be all right if the calf were fed about every two hours, as is the case when it runs with the cow. When a young calf which has been without feed for 12 hours or more is given all the milk it will take there is danger that it will gorge itself, thus causing digestive troubles. It is much safer to keep the quantity of feed well below the capacity of the calf than to risk overfeeding.

Care should be taken to see that any milk fed the young calves is of uniform temperature of about 90° F. Many feeders attempt to overcome poor quality in the feed by increasing the quantity; that is, they feed more skim milk than they would whole milk, the idea being that the added amount of the former makes up for the butterfat which has been removed from the latter. This is radically wrong. The same rules hold good in overfeeding with skim milk as with whole milk. When, on account of age, souring, dirt, etc., the quality of the milk is poor, the quantity fed should be reduced rather than increased, because the danger from infection by such milk is very much greater than from fresh milk, and the prevention of digestive troubles should always be uppermost in the mind of the feeder. The loss of development in the calf on account of a temporary reduction in the ration when for any reason it is sour or nearly so is much less than when the digestive system becomes disordered. A calf can often take a relatively small quantity of bad milk for long periods and still hold its own or even make small gains, whereas a larger portion would endanger its life or give it digestive troubles of a serious nature.

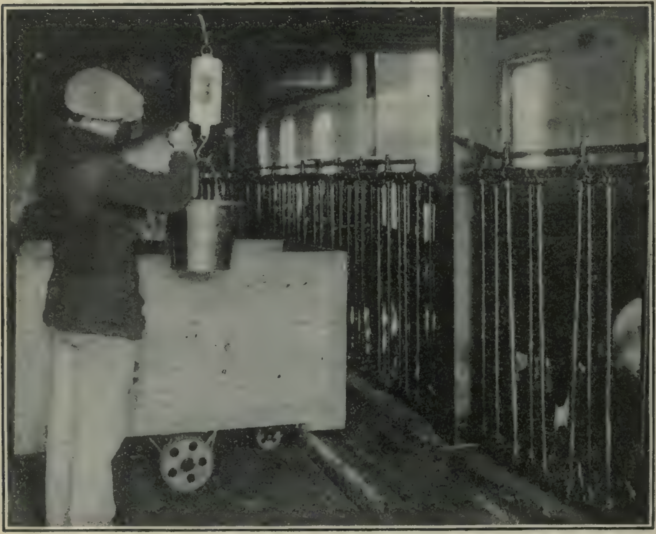

FIG. 1.—Weighing the milk for the calf.

FREQUENCY AND REGULARITY OF FEEDING.

Under natural conditions the young calf receives nourishment every 2 or 3 hours. In hand feeding it is best to follow these conditions as closely as possible, but because of the trouble and expense involved it has been found impracticable to feed calves more frequently than three times a day, and in some cases only twice a day.

It is the practice of many dairymen to feed young calves three times rather than twice a day, because the better results obtained more than pay for the additional work. When this is done the periods between feeding should be as nearly equal as possible. The chief advantages of feeding in this manner are that the calf can not overload its stomach, and that the digestion of the feed is more evenly distributed throughout the 24 hours. When calves are fed only twice a day the utmost care should be observed to see that the feedings are, as nearly as possible, 12 hours apart. The importance of regularity in feeding can not be overemphasized.

FEEDING DURING THE FIRST FIVE WEEKS.

At least four-fifths of all dairy calves are raised on separated milk, grain being used to supply the fat removed. Usually it pays well to feed whole milk for about two weeks, at the end of which time separated milk may be used in part. The proportion of the latter may be gradually increased until at the end of the fourth week it is used altogether. No fixed rules of feeding, based upon age, can be given, because the size and vigor of the calf must always be considered. Calves especially strong at birth may be put on separated milk entirely at two weeks of age, but this should not be attempted with weak ones. Until the calf is in vigorous and thrifty condition no attempt should be made to change to separated milk. This change should always be made gradually. The schedule given below for feeding calves is suggested as a guide, but it will often have to be modified to suit conditions. The supplementary feeding of roughage and grain to young calves is mentioned later under the respective headings.

FIRST AND SECOND WEEKS.

For the first four days, from 8 to 12 pounds of milk from the dam should be fed. After this time the milk may be from any cow or cows in the herd, but preferably not from any that are nearly dry. Milk containing not more than 4 per cent of butterfat is considered the best for this purpose.

THIRD WEEK.

At the beginning of the third week the substitution of either skim or separated milk may commence at the rate of 1 pound a day. The quantity of the daily ration may be increased 2 to 4 pounds, depending upon the vigor of the calf. The quantity, however, should be kept well below the capacity of the calf; that is, when it does not drink eagerly what is offered, the quantity should be cut down. In most cases, at the end of the third week the ration should be approximately one-half whole and one-half separated milk. Any increase should be made slowly so as to accustom the calf to the additional amount.

FOURTH WEEK.

At the beginning of the fourth week, from one-half to three-quarters of the milk ration should be separated milk. During the week the change should be continued until by the end of the week only separated milk is fed. With especially vigorous calves the change to separated milk may be made about a week earlier.

FIFTH WEEK AND THEREAFTER.

After this time separated milk may be fed entirely unless the calf is very delicate. The quantity fed can be gradually increased until 18 to 20 pounds a day are given. It is usually not economical to feed more than this unless milk is very plentiful.

The time that milk should be discontinued depends upon its cost in relation to the value of the calf, its breed, size, vigor, etc. The season in which it reaches the age of six months and the other feeds available at that time must also be taken into consideration. Six months is probably a good average age at which to wean calves from milk. When the best of hay, silage, and a good variety of grains are available, the calf may be weaned earlier than when such feeds are lacking. The season of good, succulent pasturage presents the best possible condition for weaning a calf, and when this exists the calf can be weaned earlier than when it is lacking. The stronger and more vigorous the calf the earlier it may be weaned with safety. On the other hand, the more valuable the calf the more expense the owner is warranted in incurring to develop it and the later it will probably be weaned. If skim or separated milk is plentiful, calves may be fed profitably until they are 8 or 10 months old.

When the calf is 2 months old, and if it is carefully watched, sour milk, whether whole, skim, or buttermilk, may be fed without harmful results, provided the change from sweet milk is made gradually. It is not well, however, to alternate between sweet and sour.

ROUGHAGE FOR CALVES.

Usually a vigorous calf begins during the second week to pick at the bedding or other material within its reach, and at that time both grain and roughage of the best possible quality should be provided. Clover hay, alfalfa hay, or, if these are not available, the most palatable roughage on hand should be given the calf after the second week. If alfalfa is used, care should be taken that it does not cause scours; this feed should be fed sparingly at first and increased only after the calf gets accustomed to it. The essential points are that the roughage be of good quality and kept clean. The usual mistake in providing roughage is that it is not kept clean. It is either placed on the floor, where it soon becomes contaminated with the droppings, or is put into a manger or feed box, so placed that the calf can easily spoil it. Hay should be furnished at first only a handful at a time and placed so that it can not get soiled. A latticework rack, of metal or wood, is useful if it is placed high enough from the floor so that the calf can not soil the hay in any manner but still have it within easy reach. This rack can be so constructed that it can be hung on the wall or framework of the stall or pen and removed when not needed. For the first six months, at least, the calf should receive all the roughage of good quality that it will eat up clean. The quantity taken up to the time it is one month old is very small. The rack should be emptied every day and fresh roughage supplied.

Silage may be given after the calf is one month old, but the utmost care should be observed to be sure that it is fresh from the silo. For this reason very young calves, except in the hands of a very careful feeder, should not be fed silage, as it ferments rapidly when exposed to the air. Care should be used in starting with silage, using only a little at first and gradually increasing the quantity as the animal becomes used to it. Generally there is no danger that the calf will get too much roughage that is clean and of the proper quality.

If the calf has access to good pasture during the first 6 months it need not receive other roughage. Pastures used in summer should contain plenty of shade. It is not advisable, however, to have a calf under 2 months of age on pasture in the early spring.

GRAIN FOR CALVES.

Whole milk is "nature's balanced ration" for the calf. When skim or separated milk is fed, other feeds are used to supply the fat which has been removed. Proprietary calf feeds or meals, for feeding with separated milk, have been put on the market. Many of these have merit, but by using the feeds usually found on the farm or in markets near by the farmer can generally mix a grain ration which is as good and costs less.

Wheat bran is a grain which is readily taken by young calves. Inasmuch as one of the essential points is to induce the calf to eat grain as early as possible, bran in many cases is one of the ingredients in the mixture. Corn, a feed very commonly found on the farm, has an excellent physiological effect upon cattle of all ages and to a great extent may take the place of the fat removed from the milk. It is therefore one of the very best grains to use with skim milk. Experiments in Virginia tend to show that corn fed to calves should be cracked rather than finely ground. Cracked corn and wheat bran therefore should be the basis of the feed mixture. Ground oats are very good for the purpose, but they are not grown on the farm so commonly as corn and in many cases cost much more per unit of feed than corn and bran. The following mixtures are recommended:

(1) Three parts cracked corn and 1 part wheat bran.

(2) Three parts cracked corn, 1 part wheat bran, and 1 part ground oats.

(3) Three parts cracked corn, 1 part wheat bran, 1 part ground oats, and 1 part linseed meal.

(4) Five parts cracked corn, 1 part wheat bran, 1 part ground oats, and 1 part blood meal.

(5) Oats, ground.

When the calf is in its second week it should begin to receive grain, and when one month old it should eat about half a pound a day. After this time the quantity of grain may be gradually increased, feeding the calf all that it will take until 3 pounds a day is reached; this will probably be some time during the third month. Grain when fed with separated milk should never be put into the milk. It is questionable whether the preparation of grain in any way, such as soaking or boiling, is advisable under any circumstances. Grain should be furnished in separate feed boxes placed so that it can not be soiled by the droppings of the calf, but at the same time where the calf can get at it readily. There should be no corners in which wet feeds may ferment, and the utmost care should be taken to keep the grain fresh and clean at all times.

MILK SUBSTITUTES.

In dairy herds in which the entire output is sold as whole milk at high prices there is a strong demand for feeds to take the place of the milk fed to the calves. While it is probably not practicable to take calves two days old from the cows and raise them entirely without milk, some skillful feeders have been able to approximate these conditions. The time at which calves can be put on milk substitutes depends upon the same factors as in the use of separated milk, namely, the breed, development, and vigor of the calves, etc. It is hardly safe, as a rule, even with the most vigorous ones, to attempt to put them on milk substitutes alone within one week after birth; and with calves below the normal in vigor, some milk for two weeks or more may be necessary to raise them. In supplying a substitute for milk an attempt is usually made to use a liquid the composition of which resembles milk as much as possible. The following milk substitutes are among those in use:

BEAN SOUP.

Bean soup for calf feeding is prepared as follows: Parboil the beans in soda and drain the water off, add water and boil the beans until soft, then press through a colander. A quarter of a pound of beans in 4 pints of water constitutes one feed at first. This should be gradually increased until the calf consumes 1 pound of beans at a feed, on the basis of two feeds a day.

ENGLISH PREPARATION NO. 1.

Wheat flour, 1 pound; flaxseed meal.[1] 2 pounds; linseed meal, 1¼ pounds. Stir ¼ pound of the mixture into 6 pints of boiling water for one feed (twice a day) at first. Gradually increase until the quantity is doubled.

ENGLISH PREPARATION NO. 2.

Linseed meal, 2 pounds; oatmeal, 2 pounds; flaxseed meal, 1 pound. Mix 1 pound with 7 pints of boiling water, and allow to stand overnight. Next morning take one-half of the mixture, add water enough to make 5 pints, boil for 10 minutes, and add ¼ teaspoonful of salt and 2 teaspoonfuls of sugar. This makes one feed for the first few days that the calf is put on this ration and fed twice a day. Gradually increase until quantity is doubled.

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[1] In preparing flaxseed or linseed for calves, it should be boiled with water or very thoroughly scalded. If merely soaked in water (cold or warm) the conditions favor the production of a poison. On the other hand, if it is fed whole or simply crushed there is no risk of poison.

HAYWARD'S CALF MEAL.

(As prepared and used by H. Hayward at the Pennsylvania Agricultural Experiment Station, State College, Pa.)

Flour, 30 pounds; coconut meal, 25 pounds; nutrium or dried skim milk, 20 pounds; linseed meal, 10 pounds; dried blood, 2 pounds. One-half pound of this mixture is stirred into 3 pints of boiling water, and when sufficiently cool constitutes one feed when the calf is fed twice a day. This is the ration at the start; the quantity is gradually increased as for the English preparations.

One of the objections to this mixture is that some of the ingredients are not readily obtained in all sections of the country.

LINDSEY'S CALF MEAL.

(As prepared and used by J. B. Lindsey at the Massachusetts Agricultural Experiment Station, Amherst, Mass.)

Ground oat flakes, 22 pounds; flaxseed meal, 10 pounds; flour middlings, 5 pounds; fine corn meal, 11 pounds; prepared blood flour, 1½ pounds; salt, ½ pound. The gruel is prepared in the usual way, by adding a little cold water to the dry meal and then about 5 pints of boiling water for each half pound of meal. The mixture should be allowed to stand until cool, and always warmed to 90° or 100° F. before feeding. The directions for feeding are the same as for Hayward's meal.

SKIM-MILK POWDERS.

One pound of powder is mixed with a small quantity of cold water to prevent the formation of lumps, then stirred into 9 pounds of boiling water and fed in the same proportion as milk.

The quantity of this powder available for calf feeding at a cost within the reach of the farmer is limited. First-grade skim-milk powders cost too much to feed to calves. In the manufacture of skim-milk powder, however, a limited quantity of low-grade product is made, not good enough to sell for bakers' or confectioners' use, which usually can be purchased at a price that permits its use in calf feeding. Under present conditions it is questionable whether these powders have wide use in calf feeding.

In feeding all milk substitutes the quantity fed should be substantially the same as when separated or whole milk is fed. If, however, there are indications of scours, the quantity should be reduced. The following may serve as a guide in using milk substitutes for feeding strong, vigorous calves:

First week	Whole milk.
Second week	Whole milk.
Third week	Three parts whole milk, one part gruel.
Fourth week	Three parts whole milk, one part gruel.
Fifth week	Whole milk and gruel, equal parts.
Sixth week	Whole milk one part, gruel three parts.
Seventh week	All gruel.

All milk substitutes lack a great deal of being as satisfactory as either whole or skim milk, and milk has to be very high in price to justify the use of milk substitutes during the first two weeks of the calf's life.

Grain and roughage should be fed with milk substitutes the same as with separated milk.

QUARTERS FOR CALVES.

Small calves should not be bumped and jostled about. An easy way to prevent this is to provide small pens, not less than 4 by 6 feet in size, in each of which a calf may be kept for the first two weeks. The pens should be fitted with feed boxes for grain and racks for hay. After the calf is old enough to run with the others it is placed with them in a larger pen. Stanchions are fixed on one side of this pen to provide for the separate feeding of the calves, so as to insure that each receives its proper share. Racks for hay should also be placed within easy reach of the calves.

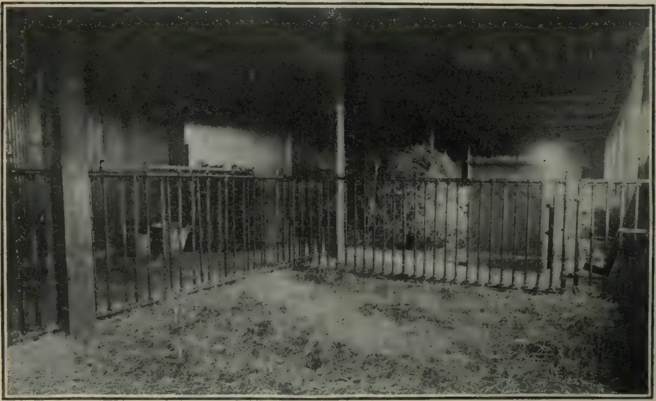

FIG. 2.—Good quarters for calves, well bedded. The metal railing on the left comprises stanchions, with feed trough just beyond (shown more clearly in fig. 1).

Too much emphasis can not be laid upon the necessity of having light, dry quarters for the calves. Bedding always should be abundant and should be changed often, in order that the pen always may be dry. Lack of attention to these matters is very likely to allow the development of the various calf diseases. Good quarters for calves are shown in figures 1 and 2.

After the calf is a few weeks old, it can stand considerable cold if it is kept dry and has dry quarters. Provision also should be made to allow the calves plenty of exercise. A small paddock or pasture adjoining the calf stables is excellent for this purpose. Except for the very young ones, calves may be let out in the exercise lot for a short period each day when the weather is not too cold or stormy.

STANCHIONS FOR CALVES.

If the calves are kept together in a large pen it is very difficult to feed them by hand unless they are tied. When they are loose the milk often is spilled, and the larger calves get part of the smaller ones' share. Very simple stanchions may be constructed to prevent losses

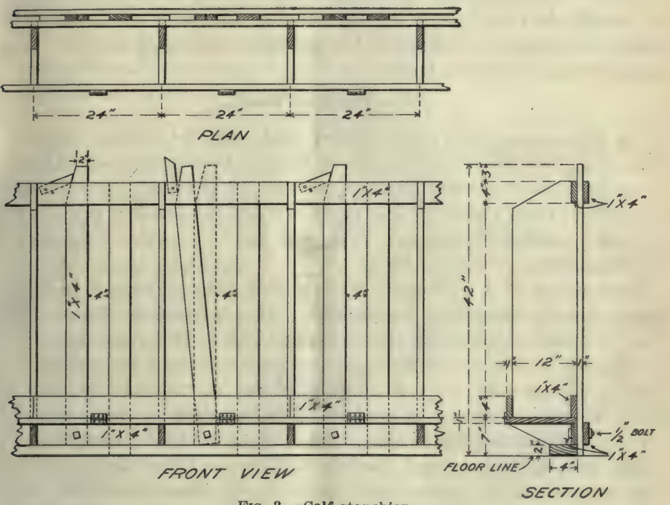

FIG. 3.—Calf stanchion.

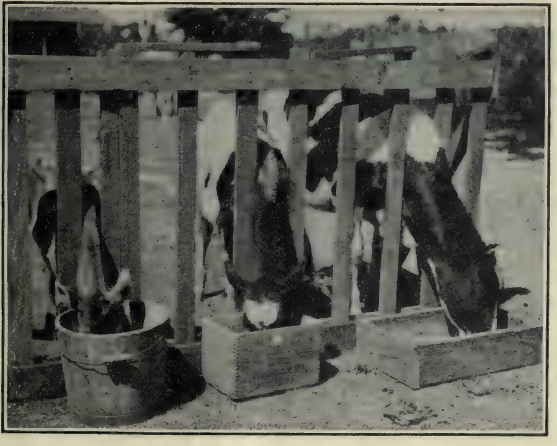

FIG. 4.—Calves feeding, showing use of stanchions.

of milk and insure the equal distribution of the feed. To prevent the calves from sucking one another they should be kept in the stanchions for some time after feeding.

A calf stanchion may be constructed of cheap or scrap lumber. It is usually 36 to 40 inches high and has a 4-inch space for the calf's head. A design for a practical stanchion is shown in figure 3. Figure 4 shows stanchions in use.

PREVENTION OF HORNS.

In the average dairy it is better that cows be without horns, as the danger of their hooking one another is thus prevented. Only in pure-bred herds, where the appearance of the herd is considered important from a show or sale point of view, is there any justification for allowing horns to grow. It is much easier to prevent the growth of horns than to remove them.

The points that ultimately will develop into horns can be felt as small buttons imbedded in the skin. The prevention is most effective if the treatment is applied when the buttons are just large enough to be felt, which is usually between the third and the seventh days. To prevent their development, the hair should be removed from the horn buttons; a stick of caustic potash or soda, wrapped in paper to protect the hands of the operator, is then moistened with water and rubbed on each horn button two or three times, allowing the caustic to dry after each application. Care should be taken to apply the caustic, which should not be too moist, to the buttons only, for if it touches the surrounding skin it will cause unnecessary pain. Immediately after the application the calf also should be protected from rain, in order to prevent the caustic from spreading. If the operation is carefully performed the horns will make no growth. If scurs or horn growths appear, it is an indication that the caustic was not properly applied.

WATER AND SALT.

Many feeders fail to realize the importance of providing the young calf with plenty of water. It is a mistake to think that because the calf drinks milk it does not need water. After the calf is two weeks old it should have access to plenty of fresh, clean water at all times, and when it is old enough to eat roughage it should have access to salt.

MARKING CALVES FOR IDENTIFICATION.

It is important that each calf be marked plainly so as to permit of easy identification. This is particularly necessary in pure-bred herds, and should be done in all herds of any considerable size, even if composed of grades.

A number of marking systems have been in general use, among which the following are some of the most common: Leather strap around the neck, with brass tag attached; ear tags of various forms; notches and holes in the ears; and tattoo marks in the ears.

The leather strap with tag around the calf's neck is a convenient method of marking. The advantages of this system are that the number may be observed readily and no disfiguration of the animal is necessary. The cost, however, is somewhat higher than that of other systems because of the first cost of the straps and tags and because their renewal is sometimes necessary.

Ear tags of various materials and forms are perhaps the most common means of identification; these tags are inexpensive and easy to attach, but have the disadvantage of being easily torn from the ears.

Marking animals by means of holes and notches in the ear is practiced in many herds, and a number of systems are in use for this purpose. Figure 5 illustrates such a marking system.

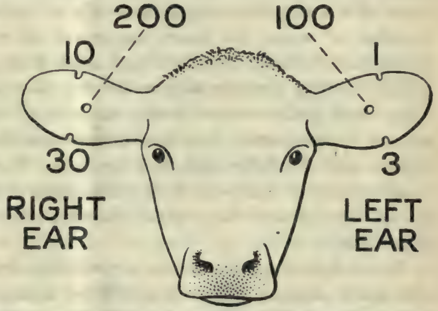

Fig. 5.—Illustration of a notch method of marking calves for identification.

The notches are made with a punch specially designed for the purpose. Care should be taken to make them so that they can be readily detected in running the fingers along the edge of the ear. Under no circumstances should they be made with a knife, as the outlines of a small cut made by such an instrument become obliterated or may be confused with the slight natural indentations of the ear as the animal grows older. It is also very difficult to make the cut of the right size with a knife, and if too large the animal is greatly disfigured. This system, while causing a slight disfigurement of the animal, is very simple, and if rightly done the notches are scarcely noticed. A serious disadvantage, however, is that mistakes in marking can not be easily corrected. To illustrate the use of this method the following examples are given: No. 7, two notches on lower edge and one notch on upper edge of left ear; No. 46, one notch on lower edge of right ear, one notch on upper edge of right ear, and two notches on lower edge of left ear; No. 152, one notch in center of left ear, one notch on lower edge of right ear, two notches on upper edge of right ear, and two notches on upper edge of left ear.

The identification of an animal by means of tattoo marks in the ears has become quite common in recent years. This system of marking animals has the advantage of not disfiguring the animal, and if properly applied the tattoo is permanent, so that the chance of losing the identity of the animal by the loss of the tag is greatly lessened. On the other hand, it requires close inspection to distinguish the marks in the ears.

CALF DISEASES.

SCOURS FROM INDIGESTION.

Diarrhea, or scours, is probably the most common disease of calves. Great care must be taken at all times to prevent this condition, as it always hinders the growth and development of the animal and in addition is often hard to cure. This disease is the result of disturbance of the digestive apparatus of the calf and may be caused in a number of ways, the more important of which are the following: Irregular feeding, overfeeding, sudden change of feed, fermented feeds, feeding dirty or sour milk or milk of diseased cows, the use of dirty milk pails or feed boxes, and damp, dirty stables. As soon as scours is discovered it is best to separate the affected calf from the others and carefully disinfect the pen. The feed should be reduced immediately at least one-half, milk pails cleaned and sterilized, feed boxes cleaned and disinfected, and any other causes mentioned above eliminated.

A number of preparations are used to treat this disease, a few of the more common of which are blood meal, a teaspoonful at a feed; white of egg; limewater, etc. A dose of four drops of formalin to each quart of milk has been used to advantage, and a drench of three ounces of castor oil followed by a teaspoonful of a mixture of one part salol and two of subnitrate of bismuth also is recommended. Ordinary white clay, mixed with water to the consistency of thick cream, and given in doses of quarter or even half a pint, three times a day, has been used recently, with excellent effect.

WHITE SCOURS.

White scours, or infectious dysentery of the calf, generally affects a number of calves in a lot, and first appears shortly after birth as a diarrhea with light-colored, offensive droppings. During the course of this disease the calf wants to sleep all the time and can not be induced to suck or drink. It is also very much weakened by the disease and usually dies within three or four days. As far as the department knows, there is no specific method of curing the disease. Ordinary white clay, mixed with water to the consistency of thick cream, and given in doses of a quarter or even half a pint, three times a day, has been found to be very valuable. Manufacturers of biological products, however, are now selling a potent serum which they claim to be effective in both prevention and cure.

Prevention consists in the use of sanitary precautions, such as clean, dry, and disinfected pens for calving, and careful disinfection of the navel of the calf at birth, painting the cord with tincture of iodin, and tying it with silk thread. As this disease is of so serious a character that it may cause the loss of a season's crop of calves, the details for the control of an outbreak should be referred to the State live-stock official or to a qualified veterinarian in the community.

FEEDING AND MANAGEMENT OF YOUNG DAIRY STOCK.

FEEDING FROM SIX MONTHS TO ONE YEAR OF AGE.

As has been previously stated, it is a common practice among dairymen to feed skim milk until the calf is approximately 6 months of age. Usually the time of weaning depends upon the availability and cost of the milk.

When milk is fed in abundance it furnishes the greater part of the protein[1] necessary for the growth of the animal. If no milk is fed it becomes necessary for the protein to be provided from some other source. Probably this can be done most economically by the use of some legume, such as alfalfa, clover, soy beans, or cowpea hay. When hay of this sort is not available it is necessary to provide the bulk of the protein through a grain mixture. In either case, plenty of roughage should be supplied to the growing heifer at all times. During summer, when good pasture is available, the heifer needs no supplementary feed, although a little hay and grain are sometimes advisable late in the season to insure steady growth.

Part of the roughage should be silage, if it is available. A heifer of six months to one year of age will consume from 5 to 15 pounds of silage a day. The grain mixture used may be the same as mentioned for calf feeding (see p. 9); any one of Nos. 1, 2, 4, and 5, together with all the alfalfa, clover, or cowpea hay that the heifer will eat. In case no leguminous hay such as that just mentioned can be obtained, No. 3 is advised, because it contains more protein. Another excellent grain mixture, to be used when such hay is lacking, is composed of 2 parts of corn meal, 2 parts of linseed meal, and 1 part of bran.

The quantity of grain to be fed depends very largely upon the individual animal's growth and condition, as well as upon the price of the grain. Some feeders desire a rapid growth of the young animal, and for this reason feed heavily with grain, while others are satisfied with a slow growth and try to carry their young stock largely on roughage. Either extreme is unwise and a medium course between the two is advisable. A safe rule to follow is to feed 1 pound of grain for the first hundredweight of the heifer and ½ pound for each additional hundredweight.

---

[1] Protein is an important component of animal food; one of its chief constituents is nitrogen. It is necessary for the making of blood, muscle, skin, milk, etc.

FEEDING FROM ONE TO TWO YEARS OF AGE.

After the heifer reaches one year of age, the following rations are suggested: Corn meal, fed according to the rule just mentioned, together with all the alfalfa, clover, or cowpea hay that the animal will consume. If no leguminous hay is available, grain composed of 2 parts corn meal, 1 of bran, and 1 of linseed meal, gluten meal, or cottonseed meal, and 10 to 20 pounds of silage, together with all the dry roughage that the animal can consume, will be found to be adequate. Under ordinary circumstances a gain of at least a pound a day from the time of weaning to the time of first calving is a good average for a dairy heifer.

AGE TO BREED.

Ordinarily it is planned to have the heifer enter the milking herd between 24 and 30 months of age. No arbitrary time can be set, as this depends upon several factors, such as the size and condition of the animal and the breed to which she belongs. Undersized and ill-conditioned animals should be allowed more time to complete their growth and to improve in condition before entering upon the strain of calving and the ensuing lactation period. It is very important that the heifer make a good growth before she is bred, because after that time she will make little body growth until after she has completed her first lactation period.

If heifers are bred to a heavy bull, care should be taken to see that they are not permanently injured. Oftentimes a breeding rack is found to be of advantage; such a rack is inexpensive and easily constructed. A better plan is to use a young bull on the heifers, which eliminates danger of injury.

HANDLING YOUNG HEIFERS.

Young heifers should be handled as much as possible in order that they may not be shy when they enter the herd. A good plan is to bring the "springing" heifer up to the barn some time before she is due to calve and get her accustomed to the halter and stanchion and to being handled. A little care in this way often prevents considerable trouble after calving, and usually insures a gentle cow.

FALL CALVING ADVISABLE.

From the standpoint of the dairyman who raises his calves, fall calving is desirable under most conditions. Under this system the calf receives milk for the first few months of its life, and at the time when it becomes necessary to wean it a succulent feed in the form of pasturage is available. As a result the calf usually makes uninterrupted gains at a minimum cost. Fall calving has the additional advantage that the bulk of the milk is produced at a time when prices are the best and when it is easiest to maintain a steady flow, and the calves are of the right age so that with careful management they may be bred to freshen in the fall or winter for the first time. This is desirable from the point of view of obtaining the longest milking period in the young heifer.

THE YOUNG BULL.

The bull calf should be separated from the heifers at about 4 months of age. His treatment and feeding should be identical with that of the heifer except that to get maximum growth he should receive a little larger quantity of grain. If properly handled, the young bull is ready for light service at the age of from 10 months to a year. Too much service before he is 2 years of age will do him permanent injury, which, of course, should be avoided. It is important that he be properly trained to halter, as this will make him much easier to handle when he is old. At 6 months of age a ring should be put into his nose.

Among some breeders it is the practice to remove the bull's horns at 2 years of age. It is asserted that this tends to tame him and prevent him from becoming vicious. One thing that should always be kept in mind is that exercise is essential to the proper development of a young bull and to the health and vigor of a mature one. A small paddock, with a shed for protection against stormy and windy weather, will give him room for plenty of exercise and keep him in good condition. Two bulls, if dehorned, may be kept together to advantage, as they exercise each other. Precautions should be taken to see that each receives his proper portion of feed.

PUBLICATIONS OF U. S. DEPARTMENT OF AGRICULTURE RELATING TO DAIRY FARMING.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Milk Fever and Its Treatment. (Farmers' Bulletin 206.)
Some Common Disinfectants. (Farmers' Bulletin 345.)
Dehorning of Cattle. (Farmers' Bulletin 350.)
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Tuberculosis. (Farmers' Bulletin 473.)
Concrete Construction on the Live-Stock Farm. (Farmers' Bulletin 481.)
Bacteria in Milk. (Farmers' Bulletin 490.)
Making and Feeding of Silage. (Farmers' Bulletin 578.)
Homemade Silos. (Farmers' Bulletin 589.)
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Ice Houses and Use of Ice on Dairy Farm. (Farmers' Bulletin 623.)
Plan for a Small Dairy House. (Farmers' Bulletin 689.)
The Feeding of Dairy Cows. (Farmers' Bulletin 743.)
Cow-testing Associations. (Bureau of Animal Industry Circular 179.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Dairy Herd, Its Formation and Management. (Farmers' Bulletin 55.) Price, 5 cents.
Breeds of Dairy Cattle. (Farmers' Bulletin 106.) Price, 5 cents.
Influence of Type and of Age Upon Utilization of Feed by Cattle. (Bureau of Animal Industry Bulletin 128.) Price, 30 cents.
Maintenance Rations of Farm Animals. (Bureau of Animal Industry Bulletin 143.) Price, 15 cents.
Cost of Raising a Dairy Cow. (Department Bulletin 49.) Price, 5 cents.

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POWDER-POST DAMAGE BY LYCTUS BEETLES TO SEASONED HARDWOOD

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FARMERS' BULLETIN 778

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. January, 1917.

POWDER-POST BEETLES often ruin stored hardwoods of the finest quality by turning them into a flourlike powder. They work in whitewood or sapwood, especially second-growth hickory, ash, and oak, which has been stored or piled in one place for two or three years or longer.

Sapwood seasoned for less than eight or ten months will not be attacked, and ***heartwood is never attacked.***

In the manufacture of hickory implement handles, when feasible substitute heartwood for sapwood. See footnote 2, page 15.

By the adoption of the following system of inspection, classification, and the proper disposal of the seasoned sapwood of hardwood stock, loss by powder-post beetles can be prevented:

> Inspect material in yards and storehouses annually, preferably in November and February, and sort out and burn material showing evidence of powder post. Burn all refuse and useless sapwood material.
>
> Classify seasoned hardwood stock into (a) hickory, ash, oak, etc.; (b) heartwood, pure sapwood, and part sapwood; and (c) according to the number of years seasoned.
>
> Utilize or sell oldest stock first.
>
> Inspect all new stock to prevent introduction of powder-posted material.
>
> Use only heartwood piling sticks in lumber piles.
>
> To prevent attack treat the more valuable material, between October and March, with boiled linseed oil. Varnish or paraffin the sapwood portions of backs and interior surfaces of cabinet work, inside finish, and furniture.

Material once attacked is usually damaged beyond repair. If the injury is not too far advanced further damage can be stopped by saturating the wood with kerosene.

While there are a number of effective chemical treatments to prevent attack, and to kill the insects in the wood, the great objection to all of them is the great and recurring expense of treating material that never would be attacked if, by the proper methods of management, the premises were kept free from the pest.

POWDER-POST DAMAGE BY LYCTUS BEETLES[1] TO SEASONED HARDWOOD.

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The sapwood of seasoned hardwood material of all kinds, both finished and unfinished, especially of hickory, ash, and oak, is often ruined by yellowish-white grubs from one-eighth to one-fifth inch in length which burrow through the solid wood in all directions and convert it into powder. These grubs are the young, or larvæ, of small, slender, somewhat flattened, reddish-brown to nearly black beetles, known as powder-post beetles. Wood that has been seasoned a year or longer is especially liable to this peculiar type of insect injury, which sometimes amounts to from 10 to 50 per cent of neglected material in storage. Powder-post damage by these beetles is widely distributed over the world and the consequent losses have been severe.

Under the general class of powder-post injury the work of insects representing several species and groups of species of beetles may be found, but by far the larger part and the most serious damage and losses are caused by different species of Lyctus.

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[1] The Lyctus beetles which are responsible for the principal losses belong to four species, viz, *Lyctus linearis* Goeze, *L. planicollis* Le Conte, *L. parallelopipedus* Melsheimer, and *L. cavicollis* Le Conte. These are discussed separately on pages 12–15.

NOTE.—Systems of control which adapt certain features in business management to the habits and seasonal history of Lyctus powder-post beetles have been perfected by the Bureau of Entomology and have been adopted by many manufacturers and dealers in seasoned hardwood products, and there has been a marked decrease in powder-post losses since 1906. The object of this bulletin is to describe the methods which have been found effective in preventing these losses and to induce a more general adoption of them throughout the United States as well as to show the character and extent of the damage.

EVIDENCE OF ATTACK AND CHARACTER OF POWDER-POST INJURY.

Infested wood may be detected by the fine, flourlike powder found on or beneath piled or stored hickory, ash, oak, and other seasoned hardwood products. During the first year of infestation the powder comes from exceedingly minute holes in the wood, but after the second year the small holes from which the beetles have emerged are more or less conspicuous, and from these the powder will fall when the infested material is moved or jarred. When the wood is cut or split the interior is often found converted into a mass of closely packed powdery material which has been held together by an outer thin shell and intervening fibers of sound wood. The grubs, burrowing through the solid wood in all directions, have pulverized the wood fiber and have packed their burrows with this powdered wood. The injury by Lyctus beetles is always confined to the white wood or sapwood, although the heartwood is sometimes penetrated when the matured beetles are emerging from the wood.

CLASSES OF FOREST PRODUCTS DAMAGED.

A great variety of seasoned hardwood products is subject to powder-post damage, especially hickory, ash, and oak woodwork of farming machinery and implement handles (see illustration on title-page, and figs. 1, 2, and 3); ladder stock, as rungs, etc.; and vehicle stock, as hubs, spokes, felloes, rims, singletrees, poles and shafts. Other products affected include woodwork of electric street cars; shipbuilding lumber (fig. 4); the Army and Navy stores of handles, tent poles, wheelbarrows, oars, and many other hardwood articles; interior finish or trim and ornamental woodwork, as panels, mantels, doors, doorposts, staircases, wainscoting, flooring, etc.; construction timber, including beams, joists, roof framing, etc.; furniture, including tables, chairs, bureaus, cabinets, refrigerators (before use), filing cases (fig. 5), piano stock, bookcases, cabinetwork, etc.; inside rustic work; wood specimens and curios in museums; cooperage stock (barrel-stave bolts); shoe-last blocks; walking sticks, umbrella handles, measuring rules, and blocks to be converted into golf-stick heads; fish-net hoops; ornamental bamboo (fig. 6); Japanese fans; shuttle blocks, and "picker" sticks (for driving shuttles in looms), etc.

Hickory, ash, and oak are the kinds of wood most liable to injury, but persimmon, osage orange, black walnut, butternut, maple, elm, wild cherry, locust, poplar, sycamore, eucalyptus, sassafras, orange wood, fig, bamboo, and other woods are also attacked.

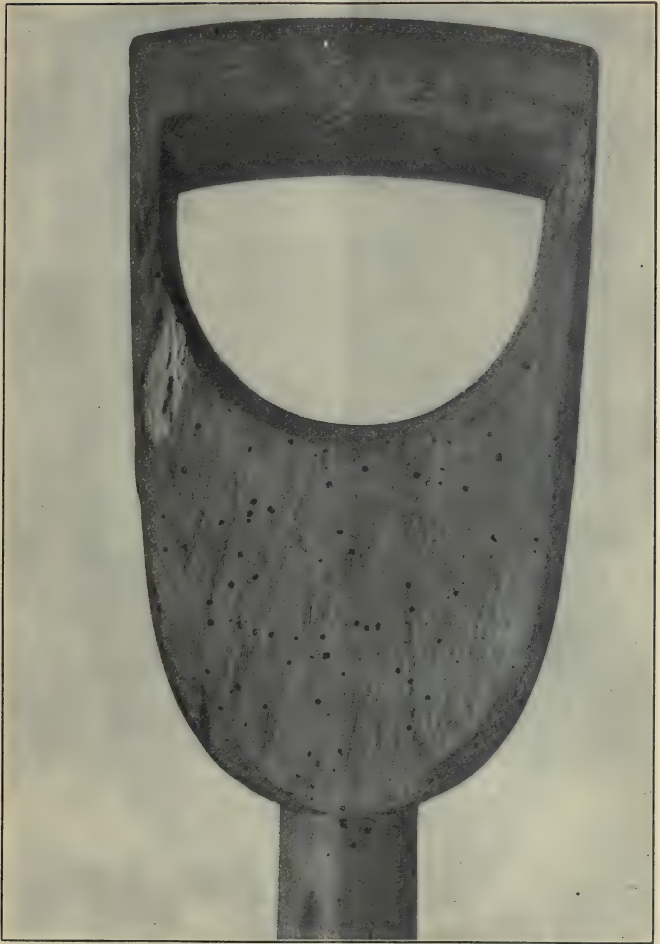

FIG. 1.—Powder-posted ash shovel handle, showing exit holes of adult beetles; the work of *Lyctus planicollis*. (Original.)

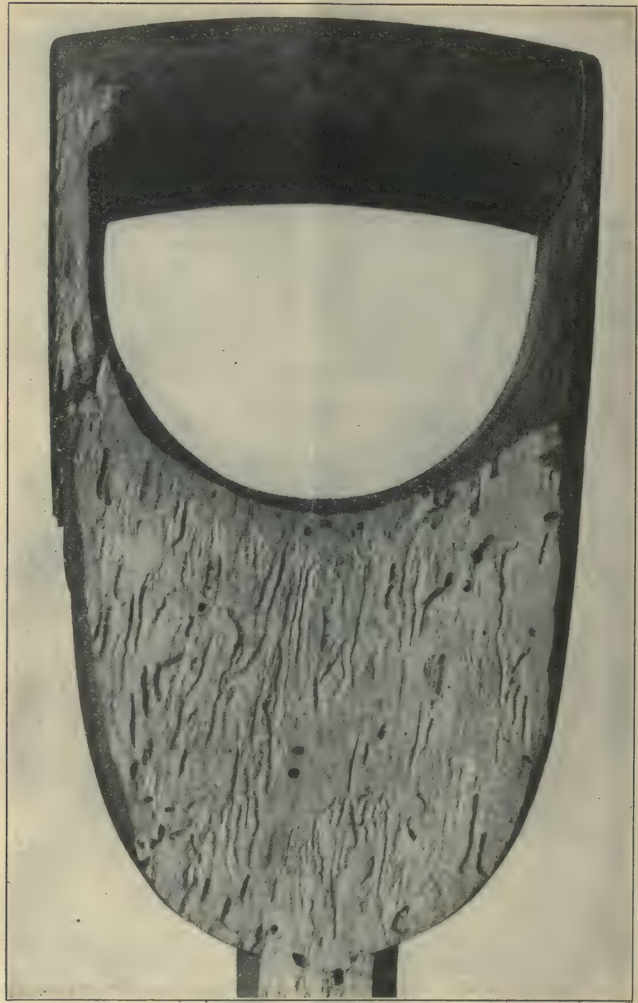

FIG. 2.—Powder-posted ash shovel handle with surface wood cut away to show burrows of larvæ within; work of *Lyctus planicollis*. (Snyder.)

EXTENT OF LOSSES AND THOSE UPON WHOM THEY FALL.

Powder-post causes a loss which falls alike on the dealer, the manufacturer or owner, and the consumer of finished products. The producer of the unseasoned or crude product is not affected, because it is only after the wood is seasoned a year or more that it is attacked and damaged by these insects. Second-growth sapwood of the best quality is particularly liable to attack and serious injury, especially when it has been stored or piled in one place for two or three years or more.

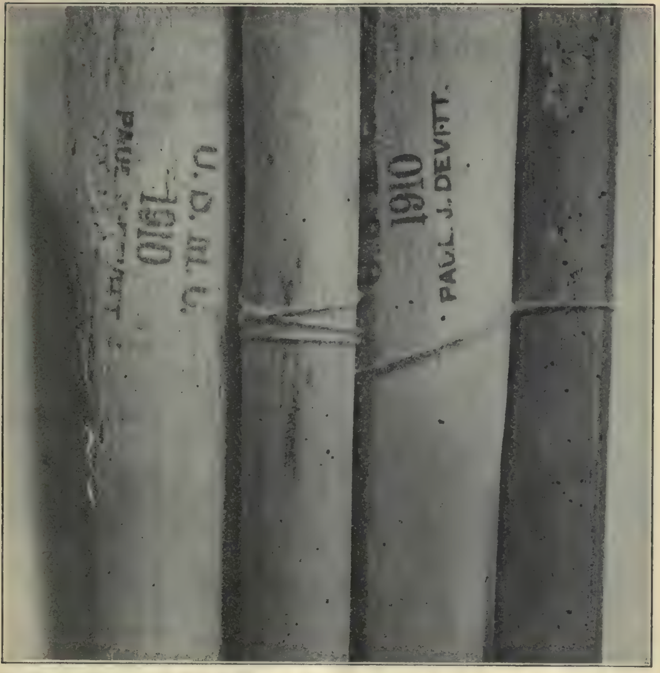

Fig. 3.—Powder-posted hickory pickax handles, showing exit holes of adult beetles; work of *Lyctus linearis*. (Original.)

The loss to seasoned hardwood products ranges from 1 to 50 per cent, sometimes representing thousands of dollars to a single manufacturer or dealer who neglects to adopt the proper preventive measures. The affected articles are not only reduced in value, but frequently are rendered worthless for the purposes for which they are intended. In the aggregate the direct financial loss that has been caused by these beetles in this country has amounted to hundreds of thousands of dollars annually. The loss increases with the length of time the infested stock is held in storage. In certain cases powder-post injury may be a menace to human life as in the weakened wood material of vehicles, ladders, etc.

CHARACTER OF THE INSECTS WHICH CAUSE THE DAMAGE.

The Lyctus beetles are small, slender, somewhat flattened, brownish to nearly black beetles, which, upon emerging from the wood where they breed and pass the winter as larvæ, fly or crawl about in search of suitable wood material in which to deposit their eggs.

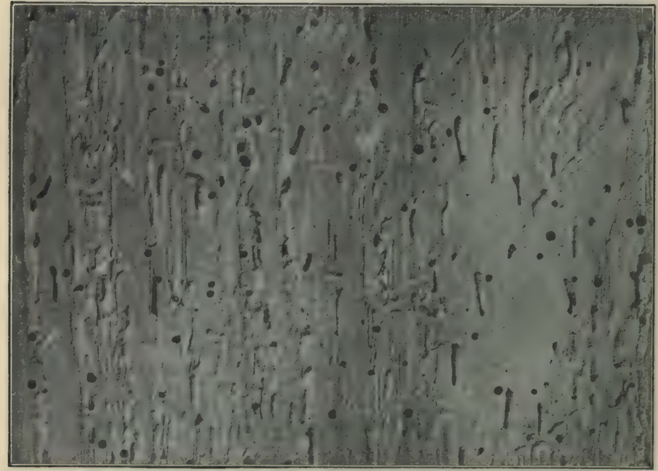

FIG. 4.—Powder-posted white ash shipbuilding lumber, showing burrows of larvæ and exit holes of adult beetles; board from closely piled stack of lumber throughout which larvæ had burrowed; work of *Lyctus planicollis*. (Original.)

HABITS AND SEASONAL HISTORY OF LYCTUS BEETLES.

There are four stages in the life history of these insects—namely, the egg, the larva or grub, the pupa or resting stage, and finally the adult or beetle.

The egg (fig. 7) is deposited in the pores of the wood by the female beetle soon after it emerges from the wood. The minute larva which hatches from the egg proceeds to burrow in and through the wood in all directions, feeding and growing as it proceeds, until it has attained its full size. The full-grown larva (fig. 8) is a yellowish-white grub ranging in length from one-eighth to one-fifth of an inch, with three pairs of legs, and with the tip of the body curved under toward the head. Upon reaching maturity as a larva it excavates a cell at the end of its burrow (fig. 9), and in this transforms to the pupa (fig. 10). Later the pupa changes to the adult beetle (fig. 11), which can fly in search of suitable places to lay its eggs.

FIG. 5.—Powder-posted oak file case, showing exit holes of adult beetles; work of *Lyctus planicollis*. (Original.)

Seasoned wood is attacked by these beetles because the chemical changes which take place in the process of seasoning render the nutritive substances in the wood, such as sugar and starch, especially suitable as food for the development of the young or larval stage.

Each female beetle deposits many eggs,[1] and many females oviposit in a single piece of wood, so that the combined work of their numerous progeny, burrowing through the wood in quest of food for their development, results in the complete destruction of the interior wood fiber and its conversion into a mass of fine powder. If the first attack and the first generation do not accomplish this destruction, subsequent generations will follow in the same wood until nothing of the solid fiber is left but a thin outer shell.

---

[1] A large female of *Lyctus planicollis* Lec., about one-fourth inch in length, that was dissected contained ovaries as two separate, elongate ovate clusters one-tenth inch in length, one of which was about one-third the size of the other. These ovaries took up most of the space of the abdomen. The eggs were arranged in rows so as to have the appearance of being braided. The mature ovules, or fully formed eggs, are pointed at one end and rounded at the other, with the rudimentary strand present at the rounded end. The egg surface is apparently granular. At least 40 eggs were in the larger mass.

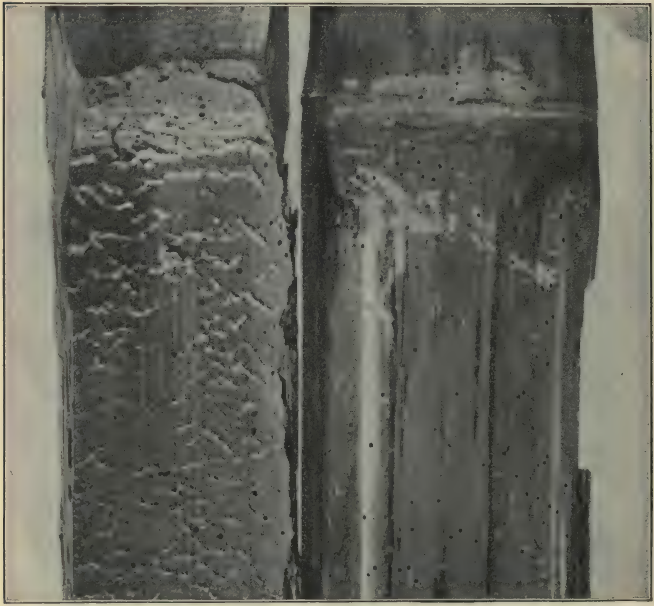

FIG. 6.—Powder-posted ornamental section of bamboo, showing exterior and interior of split bamboo; work of *Lyctus parallelopipedus*. (Original.)

The different kinds of Lyctus beetles vary somewhat in their habits and seasonal history, but there is a general similarity. They pass the winter as larvæ in the wood, change to pupæ in the early spring, and during late spring and early summer the adult beetles emerge from the wood and fly about. Under natural out-of-door conditions the eggs are laid in the pores of the wood soon after activity commences in the spring, but in storehouses, sheds, or buildings kept warm and dry, the development may take place and the eggs may be deposited much earlier.

The larvæ remain dormant or active in the wood according to the temperature of the place where stored, and in consequence infestation in wood stored in cold places may pass unnoticed. If the wood is removed from outdoors, open storage sheds, or other places which are cold in winter, to the dry kiln, the dormant larvæ start to work in the wood, as shown by the ejection of boring dust or powder. Handling or jarring infested wood appears temporarily to stop the activity of larvæ contained in it.

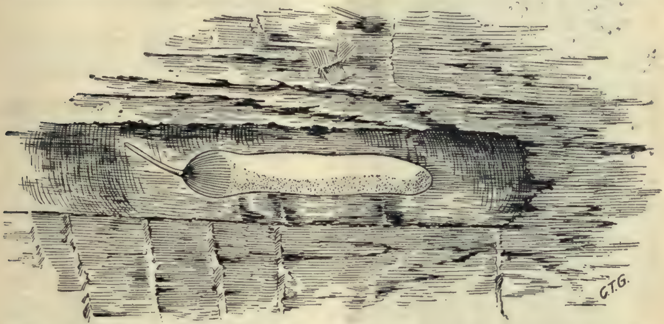

FIG. 7.—Egg of a powder-post beetle, *Lyctus planicollis*, in pore of wood on radial section of ash ladder-rung stock; pore opened to show egg. Highly magnified. (Snyder.)

In general, the adults or beetles are active between the first of March and the last of July at Washington, D. C. (about latitude 39° and longitude 77°, and practically at sea level), but the period varies according to the species, the temperature of the storerooms, and the geographical location. According to the senior author, the variation due to latitude, longitude, and altitude from a date at Washington, D. C., will be approximately four days for each degree of latitude, 5° of longitude, and 400 feet of altitude, being earlier in the season southward, westward, and descending. The number of adult beetles that might be active and deposit eggs after the last of July at Washington, D. C., is so insignificant that practically no damage is done by them. Therefore the danger of attack would be over relatively earlier at parts south of Washington and westward, and later northward. The approximate dates of flying and

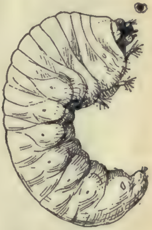

FIG. 8.—Larva of a powder-post beetle, *Lyctus planicollis*. Enlarged. (Chittenden.)

egg laying by each species under outdoor conditions at Washington, D. C., are given on pages 13, 14, and 15.

So far as known there is only one generation annually.

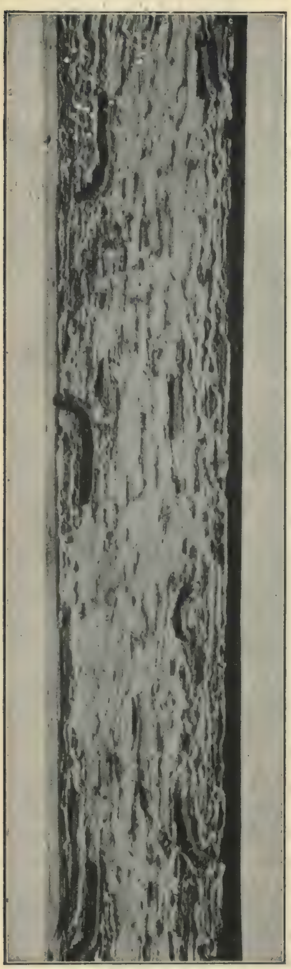

FIG. 9.—Pupal cells of *Lyctus planicollis* in powder-posted white-ash shovel handle. (Snyder.)

THE FOUR SPECIES RESPONSIBLE FOR MOST OF THE LOSSES.

While, as previously stated, there are many species of Lyctus beetles in the United States, the European Lyctus, the southern Lyctus, the velvety Lyctus, and the western Lyctus are the four species responsible for practically all the losses.

THE EUROPEAN LYCTUS.[1]

The European Lyctus beetle is rusty red-brown, slender, somewhat flattened, elongate, and from one-tenth to one-fifth inch in length. The wing covers have single rows of large, rounded, very shallow punctures.

This species is commonly met with in northern Europe under natural conditions as well as in commercial products, especially in England, France, and Germany. Therefore it is evident that it was introduced into this country from Europe. In addition to the wide distribution of this species in the temperate zones of the world, it is especially common and destructive in the States north of North Carolina, Tennessee, and Arkansas. There are a great many records of damage to seasoned hardwood products by this beetle from this area, including Maine, Massachusetts, New York, Pennsylvania, Virginia,

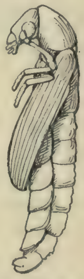

FIG. 10.—Pupa of a powder-post beetle, *Lyctus planicollis*. (Chittenden.)

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[1] *Lyctus linearis* Goeze.

West Virginia, Ohio, Indiana, Illinois, Missouri, Iowa, Michigan, and Minnesota. The great number of specimens in the collection of the United States National Museum show but a single record from the South Atlantic and Gulf States, and this is evidently a temporary introduction. Undoubtedly the species is frequently carried into the southern region, but evidently it does not survive there. This beetle is common in commercial products of seasoned hickory, oak, walnut, and ash, and occasionally in poplar, wild cherry, and locust. It is not recorded from natural growth in the open in this country, but is said to infest such growth, as well as commercial products, in Europe.

Adults of the European species, which has been shown to have a relatively northern distribution in the United States, begin activity as early as the first part of March in its southern distribution and are still active during the first part of August in its northern distribution, general emergence of the adult beetles from infested wood occurring at Washington, D. C., from April until June. The eggs are deposited soon after the adult beetles emerge and are inserted into the pores of the wood by means of a long, slender, flexible ovipositor. The winter is passed in the larval stage in the wood. General pupation occurs from about the middle of April to the first of May in the District of Columbia.

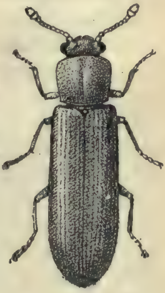

FIG. 11.—Adult powder-post beetle, *Lyctus planicollis*. (Chittenden.)

THE SOUTHERN LYCTUS.[1]

The southern Lyctus beetle is pitchy black, slender, somewhat flattened, elongate, and from one-tenth to one-fifth inch in length. The wing covers have smaller, finer, and deeper punctures in more or less distinct double rows. Individuals of this species vary extremely in size, and there is marked difference in size between the sexes, the males often being much smaller than the females. As the result of continued breeding in the same wood for several generations, in confinement the beetles were found to decrease in size.

This species is injurious to hardwood products in and from the South Atlantic and Gulf States to California, Arizona, and Nevada. This range probably represents the natural distribution of this southern species. It is frequently introduced into the Northern, Central, and Western States and transported to other countries, but this apparently never results in its permanent establishment except in warm storehouses. There are definite records of its occurrence at Cape

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[1] *Lyctus planicollis* Lec.

Town, South Africa, in lumber received from the southern United States, and at Buenos Aires, Argentina, in the ash wood in refrigerators and shovel handles from the United States.

The southern Lyctus has been recorded as breeding under natural conditions in this country and is common in the Southern States in commercial products, such as seasoned ash, oak, hickory, persimmon, and sycamore. Rearing records show that it may breed continuously in the same wood during a period of at least six years, or until all the wood tissue has been converted into powder. The beetles emerge from infested wood of commercial products in heated buildings much earlier than where exposed to outdoor conditions. Owing to the character of the class of commercial products infested by Lyctus beetles, which are often stored indoors, there apparently are no great differences in the periods of activity of adults of species of northern and southern distribution.

Adults of this southern species are active from the middle of February till the last of September in the South Atlantic and Gulf States. General emergence of the adult beetles and mating occur from the middle of April to June, and very few beetles emerge at Washington, D. C., after the first part of July. Egg laying occurs a few days after emergence, and the eggs hatch after a period of not longer than 10 days. The winter is passed as larvæ in the wood, and full-grown larvæ are in the pupal cells at Washington by the first part of February. General pupation of the larvæ in the infested wood in rearing experiments at Falls Church, Va., occurred from about the middle of March to the first part of April.

THE VELVETY LYCTUS.[1]

The velvety Lyctus is rusty red-brown to black, slender, flattened, and elongate, and from one-twelfth to one-sixth inch in length. The punctures on the wing covers are very fine and obscure and not placed in rows; the fine, dense, yellowish hairs on the wing covers are prominent, which gives the beetle a velvety appearance.

Extensive observations have been made on the habits of this species, which has been recorded as injurious in Texas, Louisiana, Florida, Georgia, South Carolina, Virginia, West Virginia, District of Columbia, Long Island, New York, Ohio, and Missouri.

The natural distribution of the species is evidently in the South Atlantic and Gulf States and in part of the Mississippi and Ohio River Valleys, from which it has been temporarily introduced into other States.

This beetle infests the seasoned sapwood of commercial products made from persimmon, hickory, ash, oak, and bamboo; it also lives in the dead wood of natural growth of osage orange, sassafras, and fig.

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[1] *Lyctus parallelopipedus* Melsh.

Adults of the velvety Lyctus are active from the middle of March till the last of August at Washington, D. C. General emergence occurs from June to the last of July.

THE WESTERN LYCTUS.[1]

The western Lyctus is a rusty red-brown, slender beetle, somewhat flattened and elongate, and from about one-seventh to about one-fifth inch in length; the punctures on the wing covers are very fine and placed in more or less distinct double rows.

This species is recorded from California in commercial products, seasoned orange wood and hickory, tanbark oak, and cordwood of live oak.

Adults of this species are active from April till the middle of September.

CONDITIONS FAVORABLE FOR ATTACK.

Second-growth white wood or sapwood of the finest quality of hardwoods, especially hickory, ash, and oak, which has been stored or piled in one place for two or three years or longer is especially liable to damage by Lyctus beetles. This is particularly the case if the material has not been handled or moved and if the old stock is allowed to accumulate. Refuse and useless sapwood material and infested stock piled about the sheds or yards, sapwood piling sticks, etc., are sources of infestation. If the different species of hardwoods are not placed in separate piles, the species of woods not so liable to attack often become infested.

CONDITIONS UNFAVORABLE FOR ATTACK.

Material of species other than hickory, ash, and oak is less liable to attack. Sapwood seasoned for less than 8 to 10 months will not be attacked, and *heartwood is never attacked*[2] (fig. 12).

The conditions will be rendered very unfavorable for attack by powder-post beetles wherever hardwood stock in yards and storehouses is handled as follows: Material inspected and rehandled annually, preferably in November and February, and that showing evidence of powder-post attack sorted out and burned; all refuse and useless sapwood material burned; as far as practicable, all dry or seasoned hardwood stock separated into heartwood, pure sapwood, and part sapwood, and into hickory, ash, oak, etc., and classified according to the number of years it has been seasoned, *and the oldest*

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[1] *Lyctus cavicollis* Lec.

[2] Exhaustive strength tests conducted by the Forest Service show that the heaviest, and consequently the strongest, hickory averages below 10 rings per inch in rate of growth, and that, weight for weight, red hickory (heartwood) is as strong as white hickory (sapwood).

stock utilized and sold first; accumulations of refuse material in which the insects could breed prevented; the introduction into lumber yards and storehouses of material infested with powder post prevented; and, finally, heartwood instead of sapwood piling sticks used in the piles.

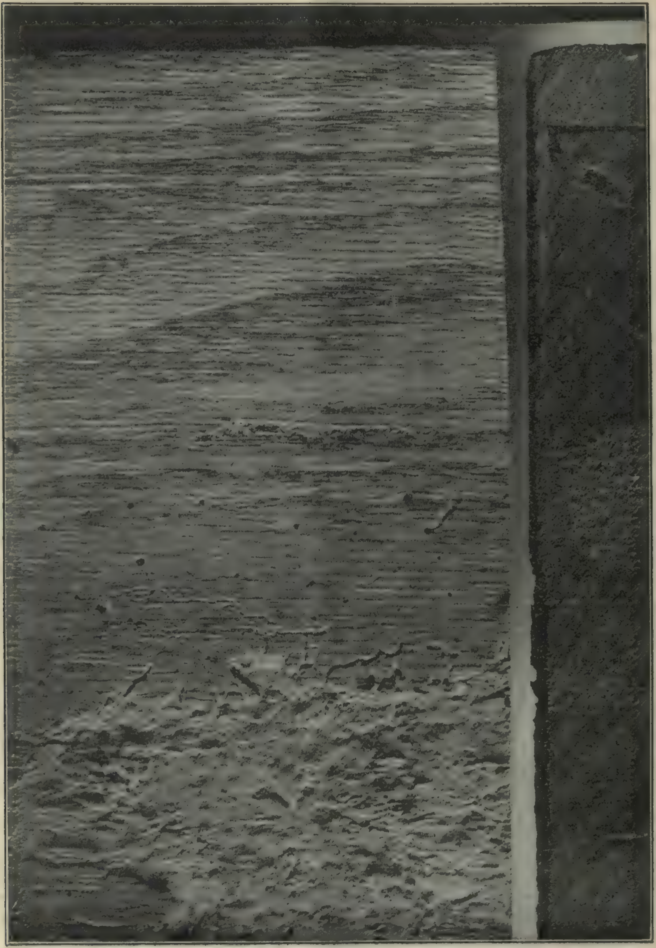

FIG. 12.—Powder-posted sapwood oak veneer laid on a core of chestnut (door stock); work of *Lyctus planicollis.* Note that the heartwood oak and the chestnut have not been attacked. (Original.)

INSECT ENEMIES OF LYCTUS BEETLES.

There are many insect enemies of powder-post beetles. Among the beetles, species of the family Cleridae are often beneficial in checking the multiplication of Lyctus beetles, the larvæ preying on the Lyctus larvæ and the adults preying on the Lyctus adults. Other beetles which commonly prey upon the powder-post beetles belong to two other families.[1]

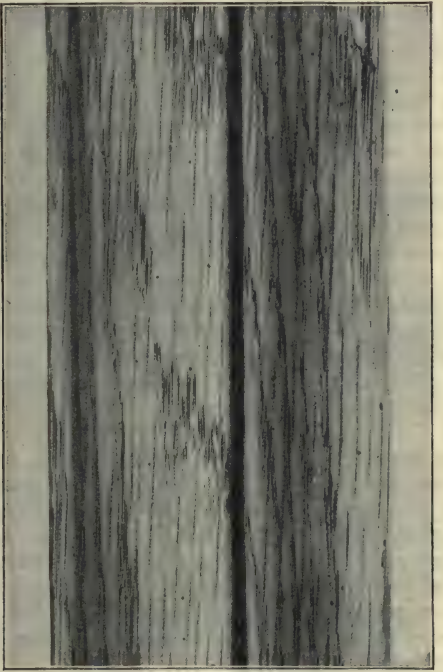

FIG. 13.—Exit holes of small, four-winged, wasplike parasites of Lyctus in powder-posted red oak interior finish. (Original.)

Many species of small, four-winged, wasplike parasites have the Lyctus beetles as their hosts. The emergence or exit holes of the adult parasites (fig. 13) are much smaller than those made by the beetles, but are often mistaken for those made by young Lyctus larvæ.

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[1] Histeridae and Cucujidae.

In general, these insect enemies, although beneficial, can not be depended upon to keep the destructive beetles under control, and therefore usually can be disregarded when practical control measures are being instituted.

METHODS OF CONTROL.

The methods of combating this class of insects and of preventing losses from their ravages come under two primary heads: (1) The destruction of the insects, or remedies, and (2) prevention of attack.

REMEDIES.

Infested material, including infested sap edges of lumber, etc., and all refuse sapwood in which the insects might breed should be eliminated by sorting it out and disposing of it by burning or otherwise. All material showing the slightest evidence of powder-post damage should be discarded and destroyed, except possibly such articles as may be tested for required strength and found to be of sufficient value for retention after treatment.

Material slightly infested and damaged should be treated with kerosene oil, after which it should be kept in quarantine a sufficient length of time to determine whether a second treatment is required.

All partially damaged material, such as the sap edges of lumber and parts of other material too valuable to be destroyed, should, when practicable, have the damaged and infested parts cut away and burned.

The work should be done between October and the first of March in storehouses, and before the first of April in the open. If this is thoroughly done and, by annual inspection thereafter, infested material is disposed of as soon as found, there will soon be no trouble from this source, unless there is a continued introduction in lumber and material received from other yards and localities where methods of control are neglected. To avoid this, all material should be carefully inspected before shipment, or at least before it is placed in the yards or storehouses.

Where it is not practicable to remove the infested parts, or in case of the more valuable stock, the wood should be subjected to methods of treatment for the destruction of the insects between October and the first of March. Of the following remedies, that most suitable in each case should be selected, remembering that the treatment must not be detrimental to the wood for subsequent uses.

(1) Liberal applications of pure kerosene oil with a brush, or immersion of infested wood in vats of kerosene. The only objection to kerosene is the fire risk. However, kerosene soon evaporates, so that the treated material is not long near the danger point. Kero-

sene oil does not affect the application of shellac or varnish; the only effect on finishing is to make it more difficult to stain kerosene-treated sapwood to match the rest.

(2) Mixtures of 3 parts creosote and 1 part kerosene oil; 3 parts kerosene oil and 1 part creosote (to obtain a deeper penetration); and 1 part creosote and 3 parts naphtha have been used successfully. The wood should be dipped in vats of preservative, preferably heated by coils of steam pipe, or the preservative may be applied hot with a brush. *Of course, mixtures containing kerosene oil should not be heated over a direct fire.*

(3) Thorough steaming of the infested wood in a tight room or under pressure. Steaming under pressure weakens and discolors the wood and should not be applied to wood to be used for fine finish or where strength is essential.

(4) Subjecting seasoned wood to temperatures over 200° F. in dry kilns.

(5) Fumigation of infested wood in tightly closed drying rooms with the fumes of sulphur at the time of the emergence of the adult beetles. This has been recommended for killing the beetles and preventing egg laying.

The objection to treating infested material lies in the fact that if it is once infested it may be damaged beyond repair and not safe for future use. A break might result in a serious accident and reflect on the reputation of the manufacturer or distributor.

PREVENTION OF DAMAGE.

By the adoption of the following system of inspection, classification, and the proper disposal of the seasoned sapwood of hardwood stock, loss by powder-post beetles can be prevented:

(1) Inspect material in yards and storehouses annually, especially stock two or more years old, preferably in November and February. Then (a) sort out and burn material showing evidence of powder-post attack and (b) burn all useless sapwood material.

(2) Classify all dry or seasoned hardwood stock as (a) hickory, ash, oak, etc.; (b) heartwood, pure sapwood, and part sapwood; and (c) according to age, that is, the number of years it has been seasoned.

(3) *Utilize or sell oldest stock on hand first. Prevent the accumulation of old stock; in other words, keep the stock moving.*

(4) Prevent the accumulation of refuse material in which the insects can breed.

(5) Use only heartwood piling sticks in lumber piles.

(6) Inspect all new stock to prevent the introduction into lumber yards and storehouses of powder-posted material.

(7) If the beetles have not been eliminated from the yards and storehouses, stock that has been seasoned longer than eight months,

and which is to be held in storage, may be rendered immune by treating it with two coats of boiled linseed oil applied hot, or it may be immersed in vats of hot oil. The boiled oil will dry more rapidly than the raw linseed oil, especially if kerosene is added to the hot oil. The wood should be treated between October and the 1st of March.

Linseed oil has an advantage over other substances in that it can also be profitably applied to unseasoned timber, since it will prevent checking in seasoning. This oil stains the wood slightly yellow. In case of wagon stock, however, it can be used without prejudice to the trade and is an effective preventive.

Creosotes can be effectively used in case of stock to which the brown stain will not be detrimental. The wood should be dipped in vats of hot creosote, or the preservative should be applied hot with a brush.

In case of finished products or more valuable material, any substance which closes the pores of the wood may be effectively applied. For example, paraffin wax, varnish, etc., effectively close the pores of the wood and prevent the beetles from depositing the eggs, which are laid in these pores. Thus the sapwood portions of backs and interior surfaces of cabinet work, inside finish, and furniture, etc., should also be treated to prevent attack.

In conclusion it may be stated that while there are a number of effective chemical treatments to prevent attack, and to kill the insects after they get into the wood, the great objection to all of them is the great and recurring expense of treating material that never would be attacked if, by the proper methods of management, the premises were kept free from the pest.

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HOW TO
SELECT A SOUND HORSE

H. H. REESE
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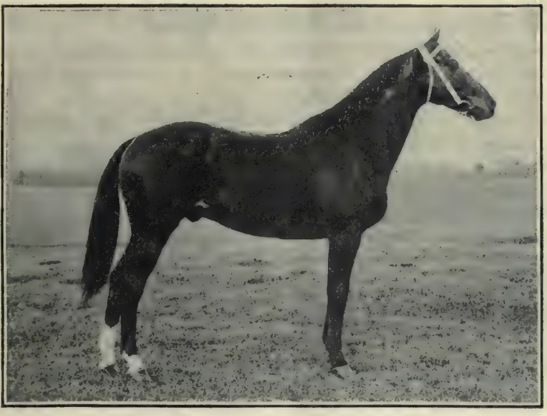

FARMERS' BULLETIN 779

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
A. D. MELVIN, Chief

Washington, D. C. **February, 1917**

THE soundness of a horse is one of the first considerations of the buyer and should be of the breeder. If the animal is not sufficiently sound to withstand the use for which he is intended, the logical time to learn of this is before the purchase.

Selection must be based primarily on a thorough, systematic examination; the examination should be based on a clear knowledge of desirable and undesirable qualities.

Not only the presence of unsoundness but also the condition or seriousness of the unsoundness should be noted.

Temporary unfitness should be distinguished from permanent unsoundness.

A hurried examination is likely to prove a disappointment.

Observe blemishes, vice, faulty conformation, unsoundness, and general characteristics.

Common blemishes are scars from old wounds, poll evil, scratches, shoe boils, and small ruptures.

Common vices are halter pulling, cribbing, kicking, stall walking, weaving, and biting.

Common faults of conformation are straight shoulders, crooked, weak, or improperly set legs, ewe neck, long, weak back, and drooping croup.

Common unsoundnesses are splints, thoroughpin, spavin, curb, extreme fistula, ringbone, side bones, extreme atrophy of muscles, contracted tendons, and broken wind.

General characteristics include fleshing, temperament, quality, color, and age.

In final selection, look for the good qualities and weigh them against the defects.

HOW TO SELECT A SOUND HORSE.

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A THOROUGH EXAMINATION ESSENTIAL.

AN UNDERSTANDING of the desirable and undesirable conditions found in horses, together with a knowledge of their relative values, will enable the purchaser to select a better animal with a considerable saving of time, inconvenience, and expense. A thorough examination for the various forms of blemish, vice, faulty conformation, and unsoundness in a horse is absolutely essential if serviceableness is to be secured, and a definite method of procedure should be adhered to in making the examination, which should correspond to the order in which the various steps most conveniently present themselves. Figure 1 names the different regions of the horse to which attention will be invited.

STABLE VICES.

Evidences of stable vices can best be seen by observing a horse in his stall.

Halter pulling.—Horses wearing extra heavy halters (particularly heavy rope halters) would be suspected of halter pulling. Likewise a rope tied from one stall partition to the other at about the height of the quarters, or the use of what is known as the body rope, may indicate this defect.

Cribbing and wind sucking.—Horses that suck air through the mouth, accompanied by a grunting sound, are termed wind suckers. Cribbers press their teeth on some object, such as the manger, while sucking in air, consequently the characteristic wear on the teeth may indicate this vice, as does also a broad strap buckled snugly around the neck at the throatlatch. Horses with these habits fill their stomachs and intestines with air, giving a bloated appearance to the abdomen. They are hard to keep in good condition and are somewhat subject to colic.

Kicking.—Heavy chains suspended from the ceiling and hanging close to a horse's hind legs, the use of chain hobbles, scars on the hind legs, and shoe prints on the partitions are evidences of stall kicking.

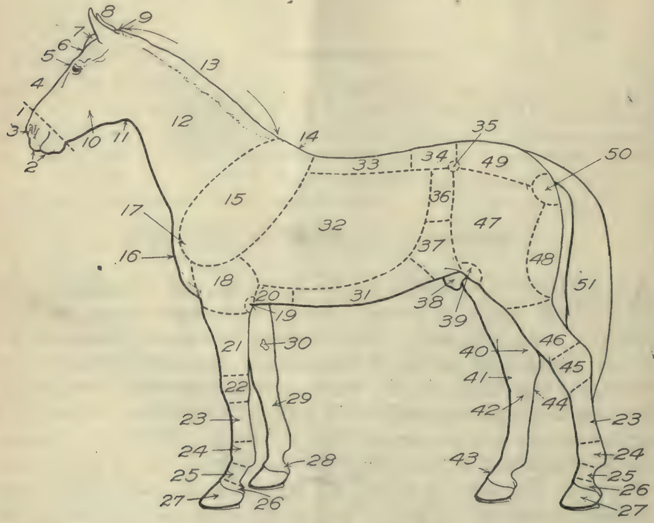

FIG. 1.—Regions of the horse.

1. Muzzle.
2. Lips.
3. Nostril.
4. Face.
5. Eye.
6. Forehead.
7. Foretop.
8. Ears.
9. Poll.
10. Jaw.
11. Throatlatch.
12. Neck.
13. Crest.
14. Withers.
15. Shoulder.
16. Breast.
17. Point of shoulder.
18. Arm.
19. Elbow.
20. Fore flank.
21. Forearm.
22. Knee.
23. Cannon.
24. Fetlock joint.
25. Pastern.
26. Coronet.
27. Hoof.
28. Seat of sidebone.
29. Seat of splint.
30. Chestnut.
31. Abdomen.
32. Ribs.
33. Back.
34. Loin.
35. Point of hip.
36. Coupling.
37. Hind flank.
38. Sheath.
39. Stifle joint.
40. Seat of thoroughpin.
41. Seat of bog spavin.
42. Seat of bone spavin.
43. Seat of ringbone.
44. Seat of curb.
45. Hock.
46. Gaskin.
47. Thigh.
48. Quarter.
49. Croup.
50. Point of buttock.
51. Tail.

Stall walking and stall trotting.—Energy-consuming vices which indicate a restless, nervous temperament are stall walking and stall trotting. An animal addicted to the former may be identified by well-beaten paths around the borders of his box stall, while the latter vice (indulged in by horses tied in their stalls) manifests itself in a trotting motion of the feet. Stall trotting is not as common as stall walking.

Weaving.—Weavers throw their heads and forequarters from one side to the other and are objectionable because they use up energy that may be needed for other purposes; they frequently stand wide on their forefeet.

Minor stable vices.—Other less important vices which may be ascertained at a stall examination are: Rubbing the mane or tail, chewing the manger, and biting and throwing back the ears when approached.

GENERAL APPEARANCE OF A HORSE.

Have the horse led out of the stable, so that he may be inspected in a good light and on a level and solid footing. Normal health is indicated by an alert, graceful carriage, rich, lustrous coat, and good condition as to flesh. If backed out of a single stall, look closely for extreme flexion of the hind legs, known as stringhalt, which is discussed later. Take a general survey of the horse from the front, rear, and both sides, so as to determine whether he is or is not built on the lines suitable to do the work for which he is wanted. Other things being equal, the heavier the horse the more he is worth for draft purposes. In fact, size is at a premium for any purpose; undersized horses seldom bring top prices. The height of a horse is determined by measuring the vertical distance from the highest point of the withers to the ground. The distance is expressed in hands, a hand being 4 inches.

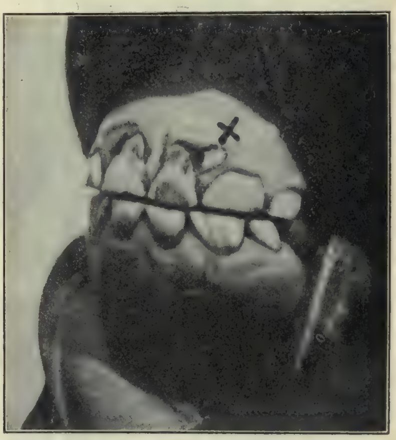

Fig. 2.—Appearance of the mouth between 2½ and 3 years of age. The center pair of temporary incisors above and below are replaced by permanent teeth at this age. The cut shows a permanent tooth making its appearance at X.

Temperament.—The temperament of a horse furnishes evidence concerning his disposition and his nerve force. For instance, the nervous, excitable animal (lacking a strong nervous system) is hard to control under many circumstances, while the sluggish, phlegmatic horse, though docile, lacks ambition and endurance. Desirable temperament is indicated by large, mild, bright eyes; width between the eyes and behind the ears; forehead neither too concave nor too convex; willing obedience to commands and an alert, active, graceful carriage when in motion. Temperament and disposition are influenced to some degree by training and handling, so that it is well to keep these factors in mind when testing the horse at work.

Quality.—Quality denotes fine texture in all that goes to make up a horse. It is not possible to examine all the parts, but those exposed to view will give a good idea of the others, since in animals there is analogy between the various parts. The external indications of quality in the horse are dense, flintlike bone, covered with fine, snugly fitting skin, and short soft hair, the two latter to be of this character over the entire body. Quality also finds expression in thoroughly defined lines between the various regions, in clean-cut features, and in a general refinement of tissue and breediness throughout. It is a well-known fact that often the smaller bones taken from the well-bred horse have more actual strength than the larger but coarser ones taken from the heavy horse. This no doubt applies in a large degree to all the other tissues, and for this reason it is reasonable to expect that the animal with quality will have endurance necessary to perform hard work.

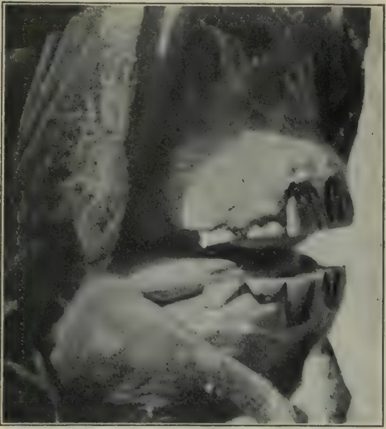

FIG. 3.—The teeth at past 3 years. The gums are inflamed around the second pair of temporary teeth, showing that they will soon be replaced by permanent teeth, when the animal will be considered 4 years old.

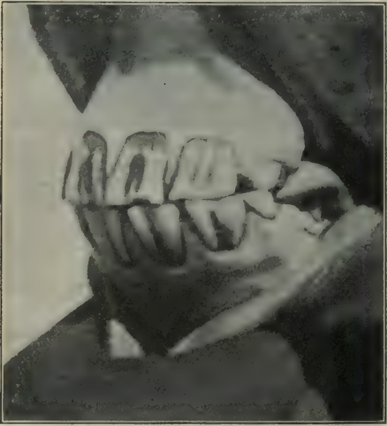

FIG. 4.—A typical 4-year-old mouth. The two middle pairs of incisors above and below are permanent. The outside pairs are temporary teeth, the latter being detected by their white appearance and small size.

Color.—Horses with any of the dark solid colors, such as bay, brown, chestnut, and black, are serviceable and sell readily. Dark grays are in demand for draft, show, and hunting purposes, but for other uses they are generally slow sellers, because they turn white with age. Pink-skinned whites, duns, mouse colors, and spotted colors sell at a discount except for uses where unusual or gaudy colors are wanted. Grays have the reputation of standing the effect of the hot sun unusually well, whereas dark browns and blacks often sunburn readily. White marks on the legs and face are desirable for show purposes, since they give a horse a flashy appearance.

Age.—If wanted for immediate hard service, a horse younger than 5 years should not be selected. A horse's value begins to depreciate when he reaches his eighth year, but he may be useful with good care until he is over 20. The teeth afford some indication of the age of a horse. (See figs. 2 to 10.)

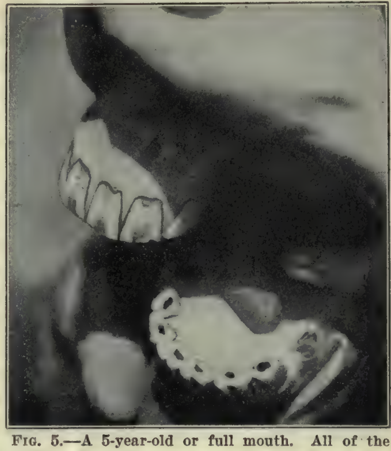

FIG. 5.—A 5-year-old or full mouth. All of the incisor teeth are permanent, but the corner incisors have not yet come into wear.

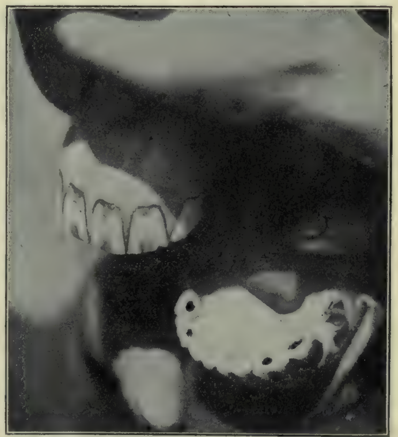

FIG. 6.—At 6 years the cups in the center pair of incisors are almost obliterated by the wearing down of the teeth. The remaining teeth show well-defined cups.

THE FORE PARTS.

Head.—The head should be small, refined, and clean cut. It should not be either too concave or convex between the eyes, the former suggesting a timid disposition, the latter strong will power. Compare the sides of the face and note any dissimilarity which may be due to disease. The side view of the head should show a comparatively straight line from the poll to the nose. Extremely heavy jaws are not desirable, especially in horses of the lighter classes.

Mouth.—The mouth should be examined for unsound or abnormal teeth. In the condition known as parrot mouth the front upper teeth overlap those below, while in reverse parrot mouth the lower front teeth overlap those above. If either condition is present the horse is not able to bite off food; and while he may eat hay and grain by getting them into his mouth with his lips, he would starve on short pasture. Tongues held outside the mouth are unsightly.

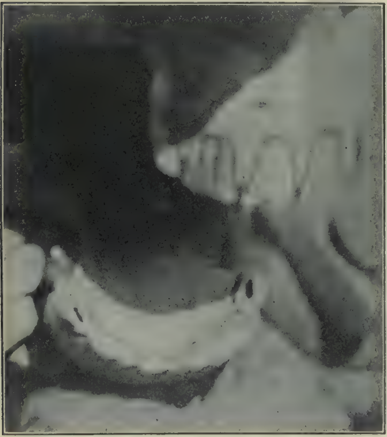

FIG. 7.—A 7-year-old mouth. The cups show plainly only in the outside pair of incisors in the lower jaw.

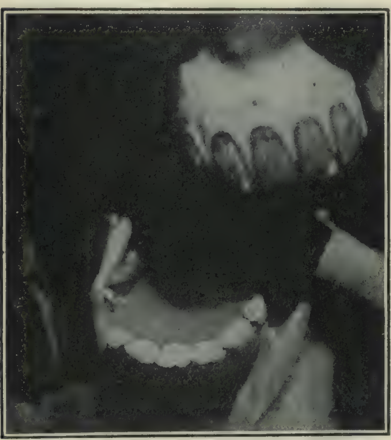

FIG. 8.—An 8-year-old mouth. The cups are worn out of all the lower teeth.

Muzzle.—The nostrils should be large, clear, and pliable, with the inside rose colored at rest and deep red during exercise. Nostrils constantly distended and hard should lead one to suspect heaves, a disease which is discussed later. Note whether the nose is deformed or crooked—conditions which mar the horse's looks. If the under lip is not held firmly against the upper it may be due to a lack of vigor. Frequent application of a device known as a twitch leaves scars around the upper lip. This would lead one to suspect that the horse has some bad habit, such as being difficult to shoe.

Face.—Look for blemishes from operations such as on bad teeth or nasal tumors, diseases which may cause trouble after apparently being cured.

Eyes.—Before beginning an examination of the eyes be sure that these important and often unnoticeably defective organs are turned toward a good light. Large, full, well-placed eyes, preferably of a chestnut hue with a sparkle and mild expression, are beautiful in appearance and are the least subject to disease. Small, sunken eyes are often weak and may accompany a sluggish temperament. Lacerations on the eyelids are more or less unsightly and give evidence of a previous injury which may have left the eye weak, especially if the eye sheds tears frequently. To test the sight make a quick motion of the hand away from each eye and see if the lids are closed to protect the eyeball. In doing this it is necessary to be careful not to cause a current of air to strike the eye, since a blind horse may close the eyelid from such a cause alone. If still doubtful about the sight have the animal led over obstacles over which a blind horse would stumble, in which case a horse with good sight will carefully raise and plant his feet over them. A more detailed test consists of taking the horse from darkness to light, and vice versa, and seeing that the pupils dilate and contract alike. Hollows over the eyes denote old age or a lack of vitality. Unscrupulous dealers have sometimes inflated these hollows with air, but this can readily be detected by

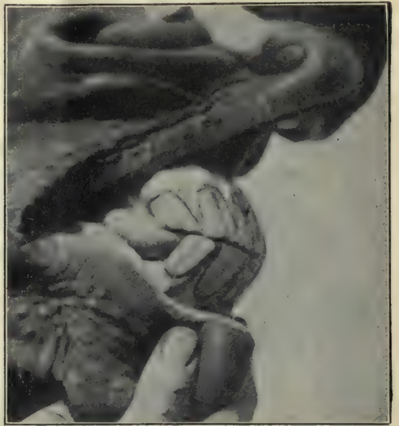

FIG. 9.—A 14-year-old mouth. After 8 years the age is estimated by the angle at which the incisors come together, by their length, and by the shape of the wearing surface. The older the horse the nearer this surface approaches a triangle. It is practically impossible to estimate the age correctly after the caps have disappeared from the teeth.

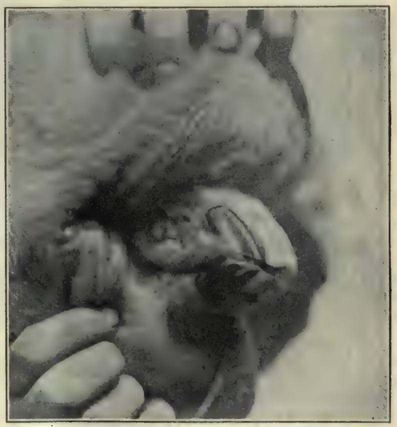

FIG. 10.—A 22-year-old mouth. The incisors meet at an acute angle and the wearing surfaces have a triangular shape.

pressing with the fingers, which forces the air into the adjacent cavities, leaving the natural hollowness.

Ears.—Horses are not often troubled with deafness, still it is advisable to test the hearing by noting responses to the voice. The ears should be placed fairly close together at the highest point of the poll and should usually be carried forward. To add to the appearance they should be of delicate texture, taper to graceful points, and be covered with fine hair. Lopped ears are very unsightly and many tricks are used to cover up such defects, such as tying together with fine thread the ear nets which the horse may be wearing, or the ears themselves may be tied together, the hairs of the foretop hiding the thread. Slight operations are also performed with the object of remedying this defect. Inspect these parts for scars resulting from the use of the twitch. Cropping or splitting the ears simply disfigures them. Horses that constantly keep the ears moving would be suspected of being blind or of bad temperament.

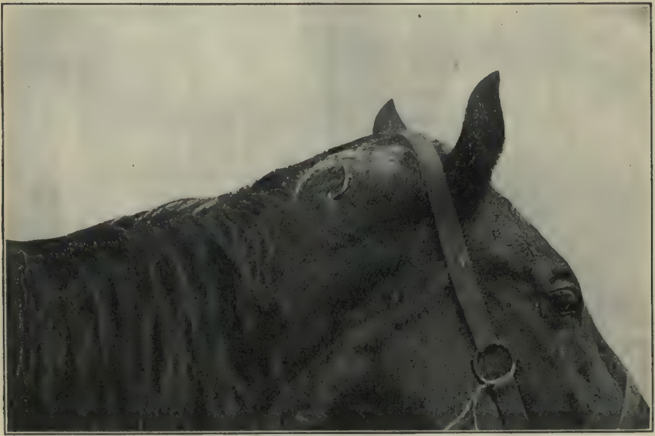

FIG. 11.—Poll evil.

Poll.—The poll should be examined for signs of poll evil (fig. 11), a disease caused by bruising the top of the head. Inflammation in this region, usually accompanied by discharge of pus, would lead one to suspect this disease, which is often slow to yield to treatment and which may break out again after it is thought to be cured. It often leaves ugly scars after healing.

Neck.—A clean-cut throatlatch on a crested neck of good length gives a horse style and beauty of outline and consequently enhances his value. In mature stallions (see fig. 26) the development of a full crest is an indication of masculinity. Evidences of bleeding, indicating previous bad health, should be looked for in the jugular vein, and it is also advisable to lay back the mane and look for scars. The neck should join the shoulders smoothly.

Shoulders.—Short shoulders do not generally indicate sufficient room for a large heart and for lungs capable of handling a maximum quantity of air. Straight shoulders favor a low, short, stubby action of the front feet. A low carriage of the head, with a heavy irresponsive mouth are often associated with a long back and a correspondingly short underline, whereas the opposite proportions, namely, a short back and a long underline, are desirable. The concussions or jars on the front legs resulting from their striking the ground are considerably relieved by sloping shoulders, while straight shoulders, by not having this effect, tend to promote early unsoundness of these limbs. Strong constitution, endurance, good front action, and style are associated with deep, well-sloped shoulders. For draft purposes the shoulders should have pronounced offsets, so that the face of the collar will have plenty of bearing surface. Figure 12 shows a shoulder of proper conformation to receive a collar. The position of the collar on such a shoulder is not materially changed, no matter how hard the pull. On shoulders such as those shown in figure 13 the heavier the pull the tighter the collar is squeezed back, with the result that the skin and muscles beneath

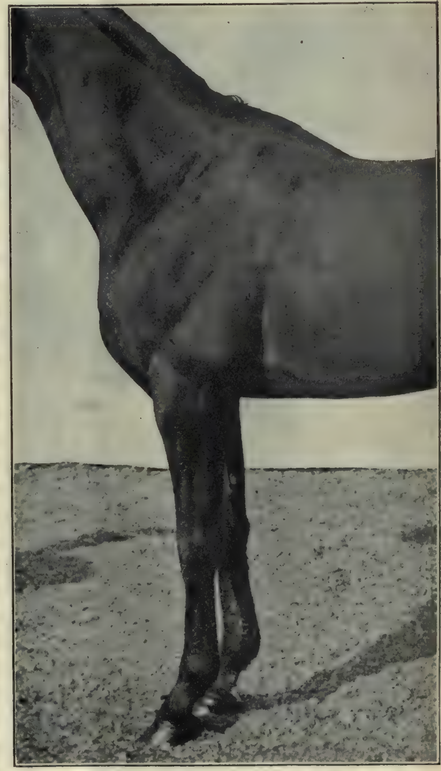

FIG. 12.—Deep, well-sloped shoulders with a good seat for a collar.

the collar are often sore. Sharp, thin, prominent withers add depth and wearing qualities to the shoulder. Shoulders that run well into the back in the saddle horse aid in holding the saddle in place. Compare figures 12 and 13.

Examine the withers for fistula, a disease similar to poll evil, except that it is differently located. Fistula is thought to result from bruising the withers, the resulting inflammation and pus being slow to yield to treatment, so that cases are often of very long standing. The disease sometimes appears to be of very minor importance, but figure 14 shows the large amount of tissue that may become involved. Fistula should not be confused with collar sores, which are often found on the top of the neck just in front of the withers. Collar sores also often occur on the sides of the neck. When not of too long standing they heal readily, if on properly formed shoulders. Calloused thickened spots resulting from old collar sores are apt to get sore again unless the collar can be kept from pressing on them. In so-called sweenied shoulders the muscles have atrophied or shrunken, and horses with such defects are practically valueless for work, for the time being, at least. Attempts are sometimes made to hide this trouble by applying irritants or by blowing air beneath the skin, giving the normal full appearance. Atrophied shoulder muscles may recover their size and development by the

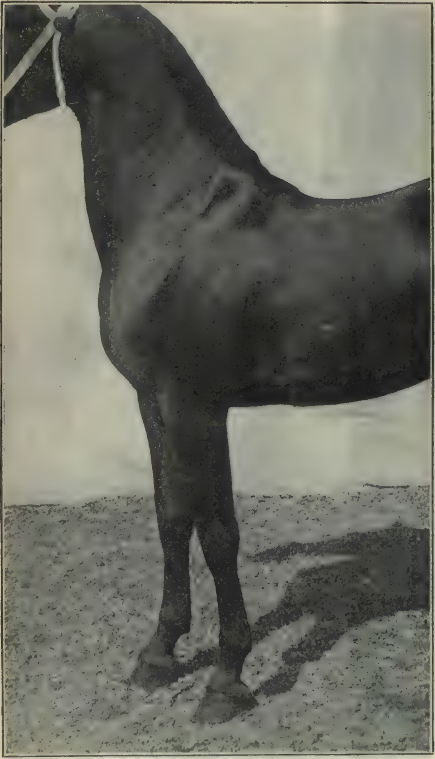

FIG. 13.—Shoulders lacking in depth and in a good seat for a collar.

removal of lameness which often arises from injury or inflammation below the knee.

Chest.—A wide chest provides abundant room for the heart and lungs, consequently a horse with such conformation would be likely to have a strong constitution. Excessive width in the chest, however, with the forelegs set too near the outside is liable to cause the horse to paddle with his front feet. On the other hand, a narrow chest is generally associated with a weak constitution and forelegs set too close together, predisposing the horse to strike these limbs together when moving. Scars on the chest are not generally any more objectionable than their disfiguring appearance.

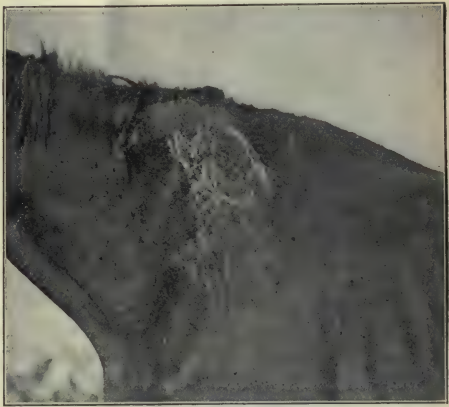

FIG. 14.—Fistula of long standing. There is considerable inflammation, with hair, skin, and underlying tissues destroyed.

Forelegs.—The proper and the faulty direction of the forelegs when viewed from the front are shown in figure 15. A vertical line from the point of the shoulder should fall upon the center of the knee, cannon, pastern, and foot. Cut A represents the right conformation; in B the forefeet toe out; in C the bowed legs have a weak appearance; D shows the extreme of knees set close together with toes pointing outward, and horses with such conformation almost invariably interfere. Cut E illustrates a form of conformation predisposing to interfering; in F the knees are set close together, showing a tendency to knee hitting; while in G the subject will wing or throw out his feet as they are elevated.

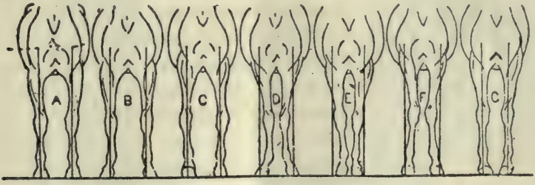

FIG. 15.—Front view of the forelegs.

The forelegs when viewed from the side should have the general direction of A in figure 16. A vertical line from the center of the elbow joint should fall upon the knee and pastern and back of the foot, and a vertical line from the middle of the arm should fall upon the center of the foot. Cut A represents the right conformation; B shows forelegs too far under the body; in C they are too far advanced; in D the subject is knee-sprung; and in E is illustrated what is commonly known as calf leg. Knee-sprung horses are apt to stumble; calf-legged horses often are sore in their forelegs after they have been used a while.

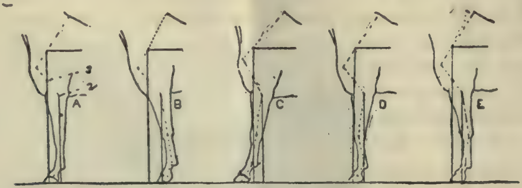

FIG. 16.—Side view of forelegs.

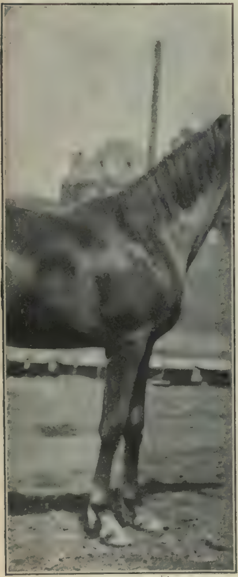

FIG. 17.—A fault of conformation known as "cut out" below the knees. The subject is apt to become knee-sprung.

The structural examination of the forelegs logically begins with the forearm, which should show strong muscular development on the outside just below its junction with the shoulder. For speed it should be much longer than the cannon. The kneecap should be broad. Scars on the inside of the knee show that the horse hits these members in moving. Figure 17 shows a cannon too light below the knee, while figure 18 illustrates a conformation that will give better service. The cannon in which the tendons and bones show prominently beneath the skin will stand hard wear, because the tissues are of a dense, tough character. The fetlock joint should be large enough to denote strength without being coarse. Pasterns that are moderately long and that slope at an angle of about 45° with the ground aid in producing elastic, springy action will absorb concussions or jars much better than short, upright pasterns. Pasterns too long and too near the horizontal are weak. The foot that is not too wide or too narrow and long, but which is fairly concave, with the frog and bars prominent will have durability. Low or contracted heels are more liable to become unsound than are fairly deep and open heels. Cracks and many nail holes indicate poor quality of the hoof.

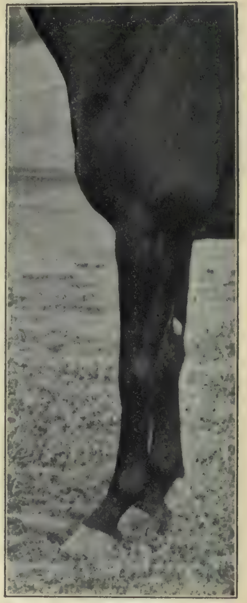

FIG. 18.—Forelegs with desirable conformation.

The following are unsoundnesses and blemishes of the forelegs: Shoe boils, which are classed as blemishes, are caused by the horse lying down cow fashion, thus pressing the elbow with the shoe. The elbows are sometimes irritated by the girth, which can easily be padded or properly placed, thus avoiding a continuance of the trouble. The forearm is usually free from unsoundness, but it may be blemished by injuries such as wire cuts. Scars on the front of the knees would lead one to suspect a stumbler.

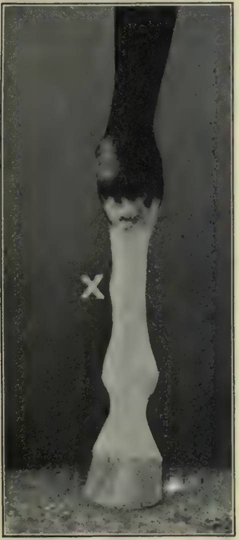

FIG. 19.—Splint at X.

Bony prominences known as splints (fig. 19), found on the inside of the cannon just below the knee, may cause lameness when first developing or when close enough to the knee to interfere with its movement. Splints frequently disappear from young horses. The front of the cannon may be full, or the tendons at the back may be enlarged, as shown in figure 20; they are conditions brought about by training and racing and are known as bucked shins and bowed tendons respectively. They incapacitate a horse for fast work. The scars often associated with these conditions are due to the firing iron. Wind puffs, illustrated in figure 21, are due to fast or continuous road work, and while they do not decrease a horse's immediate usefulness, they show that the animal has had considerable use. If the fetlock joint is unduly large it is more or less unsound (fig. 22). This enlargement may be permanent, from an old injury, or it may be due to hard or fast work followed by a lack of exercise, or to disease. The slight fullness that promptly disappears with exercise is about as objectionable as wind puffs. Interfering when associated with forelegs set close together or with toeing out considerably depreciates the value of a horse, especially for anything other than slow work, and it is to be suspected when scars are found on the inside of the fetlock joint.

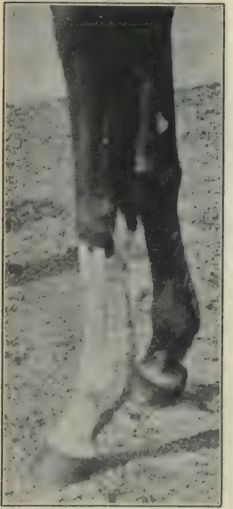
FIG. 20.—Bowed tendon.

Ringbone (fig. 23) is an unsoundness characterized by bony enlargements on the front and sides of the pastern, which cause lameness when developed to sufficient size to interfere with the action of the joints and tendons. These bony prominences can be detected by passing the hand over the pastern if they are not large enough to be seen when in front or at the sides of the forelegs.

Side bones can best be seen from the front, as shown in figure 24. They occur on the sides of the coronet. When not prominent enough to be noticed by the eye their presence may be detected by grasping the back of the coronet between the thumb and fingers and pressing. If healthy it will yield to pressure; if unsound it will be hard and rigid. Side bones on the forefeet interfere with action and may cause lameness.

Scratches is the name given to a cracked condition of the skin at the back of the pasterns and over the heels. This trouble is not serious but is hard to heal unless the horse can remain inactive for some time. In animals of a pacing gait the quarters may show scars from cross firing or hitting this region with the hind foot on the opposite side. Scars resulting from barbed-wire cuts are objectionable only on account of their ugliness.

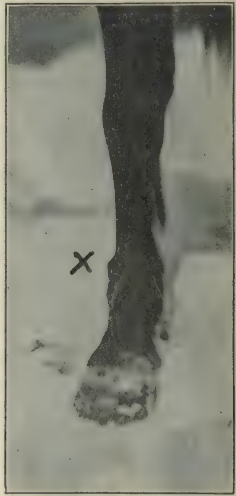

FIG. 21.—Wind puff at X.

Pick up a foot and note the willingness with which a horse lets you hold it. This should aid in discovering a subject difficult to shoe. The feet should be free from diseases such as thrush and corns, which hinder action. Navicular disease is to be suspected when a horse stands with a forefoot extended and with the toe only resting on the ground. This disease impedes the gait and usually causes lameness. Slight ridges on the walls of the hoofs parallel with the coronary band may result from stomach and intestinal disorders, while more pronounced ridges close together at the toe and far apart at the heel, if accompanied by dropped sole, would indicate a previous case of founder, a disease which usually leaves a horse sore and stiff in his forefeet.

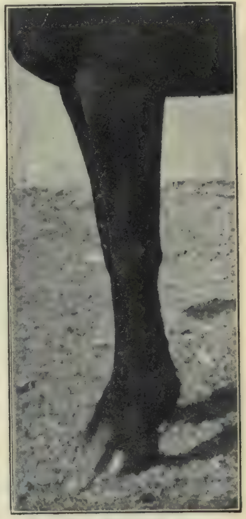
FIG. 22.—Enlarged fetlock joint.

THE BARREL, OR BODY.

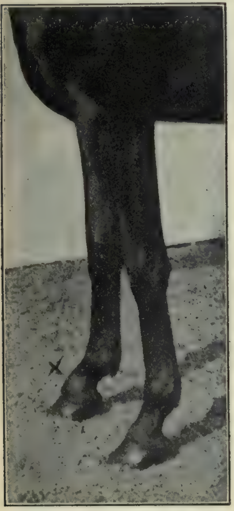

FIG. 23.—Ringbone at X.

The conformation of the barrel has much to do with a horse's health and appearance, as it determines to a considerable degree the size and strength of the vital organs. The back should be short and straight, the ribs well sprung from the backbone and of sufficient length to form a deep barrel. The distance between the last, or floating, rib and the point of the hip should be short. The last rib should not be sunken, but should be prominent, giving a smooth coupling. With a short, well-muscled loin and a deep flank (together with a smooth coupling) a horse should be an easy keeper and should not look tucked up or gaunt after a hard day's work.

As regards unsoundness or blemish in these parts, hernia or rupture occurs on the abdomen at or near the navel. Small hernias, such as shown in figure 25, are merely unsightly, while larger ones depreciate a horse's value in direct proportion to their size. The barrel should be free from sitfasts or saddle and girth sores. An enlarged sheath is generally due to disease. Mature stallions should have two prominent testicles; ridglings have one testicle that has not descended into the scrotum and are very annoying to handle because they have the desires and actions of a stallion. They can be completely castrated only by a severe surgical operation. Mares which have produced colts have well-developed teats.

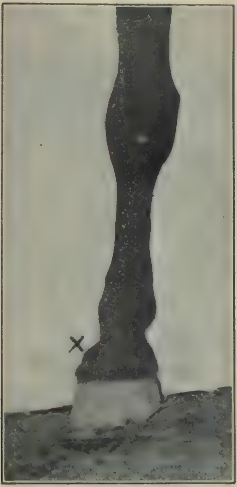

FIG. 24.—Sidebone at X.

THE HIND PARTS.

Hind quarters.—Both points of the hips should be similar and on the same level. They should not be too prominent (condition as to flesh being considered), but should be a good distance from the point of the buttock. A low or capped hip detracts from a horse's appearance. In draft horses the hips should be broad, and the muscles on either side should stand well above the level of the spine if the horse is in good order. In the lighter types the hips should be smooth and more nearly circular in outline. In general, width across the hips with proper muscling denotes power. A fairly level croup with the tail attached high gives the horse beauty of outline, and this is increased by a long tail carried out gracefully from the body. A tail carried to one side or with a crook in it mars the animal's attractiveness. If the tail has been rubbed it may be due to intestinal parasites, external parasites, or high feeding; even if due to habit alone it would be objectionable. Raise the tail and ex-

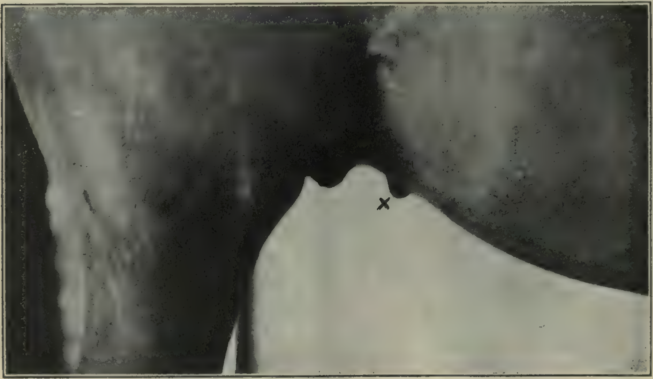

FIG. 25.—Hernia, or rupture, at X.

amine for crupper sores, warts, and signs of worms, the latter making the horse dull and hard to keep in flesh. Warts under the tail are usually found on old horses of gray color. They make the tail heavy and interfere with the crupper. Horses are sometimes made to carry their tails high temporarily by gingering, which causes an unnatural carriage with twitching.

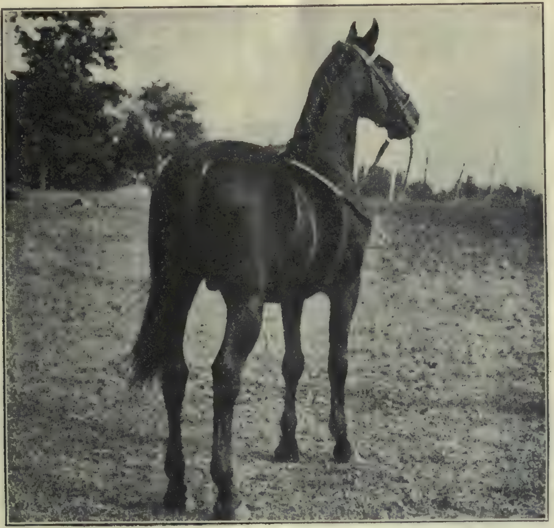

FIG.—26.—Rear view of a horse of light type, showing correct conformation of croup, quarters, gaskin, and hind legs.

The quarters should be round, full, heavily and smoothly muscled, and should strongly join the gaskin; the latter also should be heavily muscled. Quarters separated to an unusual height when viewed from behind characterize an animal lacking a vigorous constitution. Atrophy of the muscles in the region of the stifle joint and dislocation of this joint are conditions which totally incapacitate. Figure 26

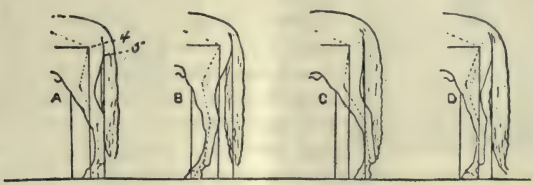

FIG. 27.—Side view of hind legs.

shows quarters and gaskins of good conformation. They are well proportioned, properly set, heavily and firmly muscled, look well, and are capable of developing great power.

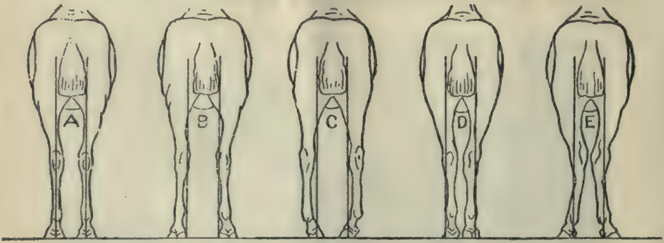

FIG. 28.—Rear view of hind limbs.

Hind legs.—Cut A in figure 27 illustrates the proper direction of the hind legs viewed from the side. A vertical line from the hip joint should cross the center of the foot and divide the gaskin in the middle; a vertical line from the point of the buttock should coincide with the back of the cannon. In cut B the hind legs stand too far under the body; in C the hind legs are set too far back; and in D the hock joint is too straight. Other things being equal, the direction shown in A makes the limb much stronger and more serviceable than those in B, C, or D.

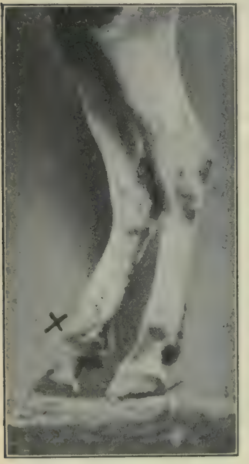

FIG. 29.—Crooked hind legs with cocked ankle at X.

Viewed from the rear, the hind legs have the greatest strength when they have the direction shown in cut A of figure 28. This direction is correct when a vertical line from the point of the buttock crosses the center of the hock, cannon, pastern, and foot. B shows hind legs set too far apart, tending to produce a sprawling gait. In C the hind feet toe in or are pigeon-toed, the joints being improperly formed, producing considerable undesirable lateral motion when the foot is carried forward. With such conformation the feet can not be carried in a straight line. In D the hind legs are set too close together, predisposing the horse to interfere. The condition shown in E is generally known as cow hocked, and hind legs so formed do not have the strength of those in which the columns of bones are placed directly over one another.

Hock.—The angle of the hock determines to a large extent the direction of the hind legs. The greater the angle the straighter the hind legs and the more apt is thoroughpin to develop. If the angle is small the hind leg is crooked and consequently weak. Puffy, meaty-looking hocks covered with thick skin and coarse hair are apt to become unsound. Hocks on which the skin fits snugly against the bones and ligaments generally wear the best. Compare the hocks closely and see that they match exactly, as failure to do so would indicate unsoundness and should cause the horse to be rejected. A common defect of the conformation of the hind legs is known as "cut out below the hock." In this the junction of the hock with the front edge of the cannon is lacking in development, denoting weakness. It is sometimes associated with the following: The heavy bone on the outside of the hock (shown in fig. 34) extends too near or past the vertical line coinciding with the back of the hind leg, making curb very liable to develop. The cannon of the hind leg is much broader than the cannon of the foreleg. Figure 29 illustrates a fetlock joint that stands over the hoof, called cocked ankle. Contracted tendons at the back of the cannon cause cocked ankle, a condition making the leg stiff and weak. The remainder of the hind leg should correspond in general conformation to that of the foreleg, except that the hind pasterns and hoofs are slightly straighter with the heels slightly higher. (See fig. 30.)

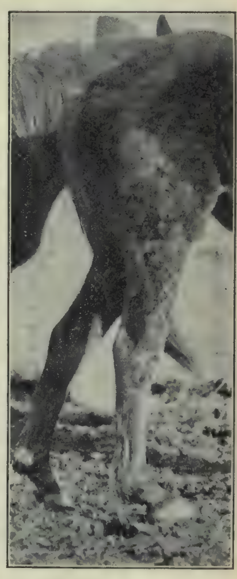

FIG. 30.—Hind legs too straight, with pasterns too sloping.

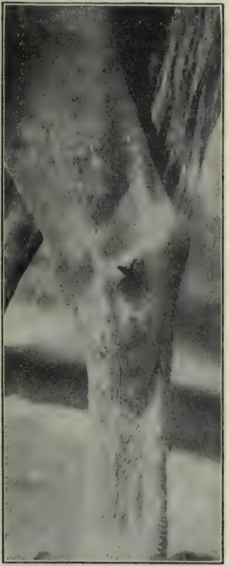

FIG. 31.—Thoroughpin at X.

Thoroughpin (fig. 31) is due to a collection of synovia in the depressions which lie just below the tendon running from the point of the hock into the gaskin. It can best be detected by pressing the swelling on one side of the leg and noting the corresponding filling on the opposite side. Thoroughpin may cause lameness, is unsightly, and depreciates the value of the animal. The point of the hock sometimes becomes thickened from a bruise, which condition is shown in figure 32 and is termed capped hock. It does not impair a horse's usefulness.

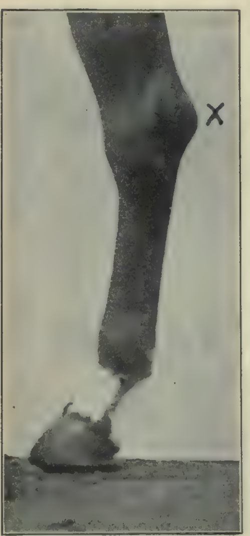

FIG. 32.—Capped hock at X.

Bog spavin is an enlargement in the natural depression on the inner and front part of the hock, formed by a collection of synovia which is soft to the touch. It can best be seen from obliquely in front, as shown in figure 33. This unsoundness sometimes causes lameness, consequently lessening the animal's value. A large blood vessel passes over this region of the hock, and this may become enlarged, giving the appearance of a bog spavin, but as this condition never leads to lameness it is considered a blemish rather than an unsoundness. Fullness at the back of the hock below the point observed from the side as shown in figure 34 is due to a thickened ligament which may be ossified in long-standing cases and is known as curb. Curb, especially when first developing, causes lameness.

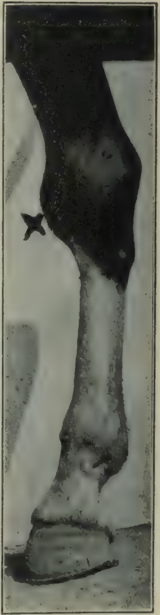

FIG. 33.—Bog spavin at X.

Bone spavin (fig. 35), located on the inside of the hock where the thick bony part tapers into the cannon, is a bony enlargement and can best be detected by comparing the inside of the hind limbs from squarely in front or behind. Occasionally bone spavin can readily be seen from obliquely in front. If a horse appears to have a bone spavin, the following test will give further proof of its presence, provided the leg carries no other unsoundness that would cause limping. Pick up the suspected limb and hold it in a well-flexed position, then start the animal at a trot as soon as the foot reaches the ground. If bone spavin exists in an active form, the horse will limp.

Stringhalt (fig. 36), a disease characterized by extreme and unnatural flexion of the hind limbs, hinders action. It can be most advantageously discerned when a horse backs out of a single stall after being idle for some time.

Splints do not generally occur on the hind limbs. Unless developed to an unusual size, side bones do not interfere with the action of the hing legs. Ring bone frequently occurs on the hind pasterns.

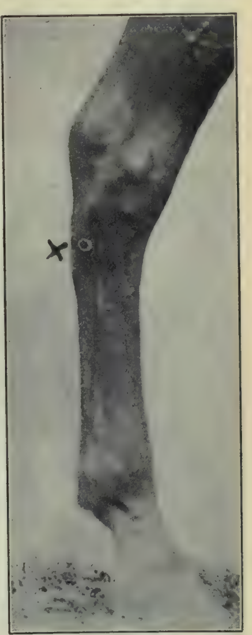

FIG. 34.—Curb at X.

THE HORSE IN ACTION.

Lameness due to a variety of causes and of various forms, some not at first apparent, should be carefully looked for when examining a horse in action. When lameness is present only at certain times it is known as intermittent lameness, consequently it is advisable to examine a horse on several different occasions. In cold lameness the animal will go sound after he is warmed up, while in warm lameness the impediment does not manifest itself until after considerable exercise. Flinching when the horse turns sharply indicates shoulder lameness. The various gaits should be observed from the front, side, and rear, in order that the desirable features and defects may not be overlooked.

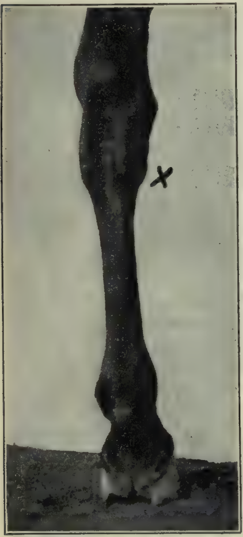

FIG. 35.—Bone spavin at X.

Walking.—Perfection in this gait is characterized by the feet being brought up quickly from the ground, by their being carried in a straight line, by lengthy stride, and by the cycle being completed quickly. All of these aid in producing a rapid walk, which is a great asset to horses used for any purpose. The defects of gait which may well be noted while the horse is walking are interfering, winging, toeing in or toeing out, and sprawling.

Trot.—This gait must be square; that is, it must be without any tendency to wabble, shuffle, or mix gaits, and the hind feet should follow in line with the forefeet. In the roadster and trotting race horse speed is highly valued, while in the park saddle horse a fair degree of nicely balanced knee and hock action is demanded. The highest prized factor of the harness horse expresses itself at the trot in extreme knee and hock action. Even in the draft horse a square, open, well-balanced trot with pronounced knee and hock action adds many dollars to his selling price. The common defects of the trot are interfering, forging, scalping, sprawling, dwelling, hopping, and knee action without a proportionate amount of hock action or vice versa. Lameness may be detected in the trot when it may not be apparent in other gaits. An abundance or lack of energy and ambition is apparent during trotting by the general deportment and carriage.

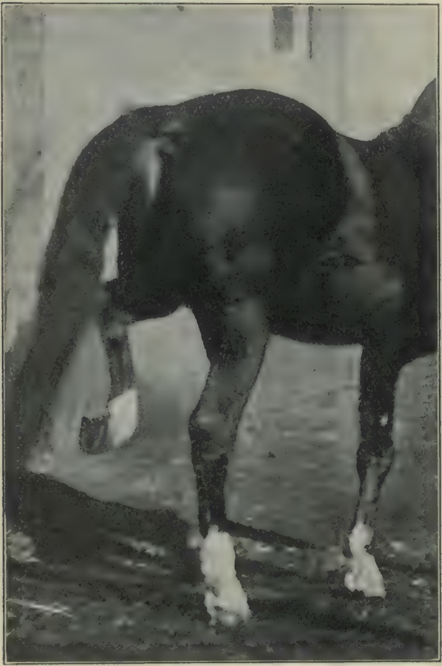

FIG. 36.—Stringhalt.

Pace.—The pacing gait is more or less common in harness horses, and it is useful as a fast road gait on smooth thoroughfares. The characteristic movements of the limbs in this gait consist in the feet on the same side of the body striking the ground simultaneously. The principal defects of the pace are cross firing and hitting the knees.

Easy gaits.—Plantation horses and 5-gaited saddle horses have gaits that are easy on the rider as well as on the horse. Such gaits are desired principally for long rides and are known as slow pace, fox or dog trot, and running walk. Any one of them may constitute one of the gaits of a 5-gaited horse, while the faster easy gait demanded in such a horse is the rack or singlefoot. This is intermediate between the trot and pace, the feet hitting the ground one at a time, producing a gait easy on the rider but tiring to the horse.

Canter.—The canter, classed as a saddle gait, may be described as a modified, collected, and very slow gallop. It should be graceful, easy, and handily performed.

Wind.—To test the wind have the horse ridden at a very fast gallop, stopping him abruptly so that you may hear the passing of air through the windpipe. In roaring, or broken wind, there will be a whistling sound each time the horse inhales. When a horse is affected with the disease called heaves, it has difficulty in forcing air out of the lungs, causing a peculiar and very characteristic movement in the flanks and abdomen, especially after exertion. Horses affected with heaves usually cough in a characteristic manner after drinking cold water. This cough may also be excited in affected horses by tightly grasping the windpipe at the throatlatch for a short time. A horse's respiration is greatly hindered by either broken wind or heaves.

Adaptability for specific work.—A horse may possess proper conformation, be sound, and have good action yet still not be well adapted for a specific work, consequently it is very essential that he be thoroughly examined at the work for which he is wanted. If the horse is to be used for heavy hauling or draft purposes, steady pulling under all conditions is an indispensable quality. For harness use the horse should drive promptly and freely with an easy, rapid gait and an alert expression, taking just sufficient hold of the bit to be in hand without causing the driver to pull on the lines. The saddle horse should have an easy, prompt mouth, with style and graceful carriage.

Vices.—Some horses are difficult to harness and object to taking the bit in their mouths; others jump when an attempt is made to place a saddle or harness on their backs; while still others offer a great deal of resistance to having the crupper placed under their tails. If the resistance is due entirely to a heavily muscled and consequently a strong tail it may be an indication of general muscular strength and tension. While being hitched up or mounted the horse should stand quietly and should start promptly but quietly on command. For any purpose the following vices should cause the animal to be rejected: Balking, backing, rearing, kicking, striking with the forefeet, or running away. Less important vices are: Throwing the head up or down, shying, scaring, breaking loose when tied, resting one foot upon the other, grasping the bit between the teeth, rolling with the harness on, or switching the tail over the lines. Occasionally the last-named vice causes the horse to kick, in which case it becomes dangerous.

CONCLUSION.

Enlargements or scars (due to deformity, unusual mishap, or uncommon disease) not conforming to any of those discussed should cause a horse to be rejected unless the nature of the cause and the detriment to the value and usefulness of the animal is self-evident. Experience gained by examining large numbers of horses will aid in quickening the eye and judgment, thereby making it possible to perceive readily any unusual condition, but it should be remembered that a hurried examination is liable to prove a disappointment, consequently plenty of time should be taken in making the examination, because time is much cheaper than money tied up in an unsatisfactory horse. In some countries nine days are allowed by law to the purchaser in which to learn of the serious forms of unsoundness or vice in a horse, so that in this country it would seem fair to allow at least a day for a fair trial when practicable. If possible, get a history of the animal, and while you are about it, get a history of the person having it for sale. So many defects may be covered up by such unfair methods as drugging that it is a good plan to make purchases only from those with good reputations. Horses offered at auction sales should be thoroughly examined previous to their being brought into the ring, or else they should be tried out in compliance with the rules of the sale before time for settlement.

Finally, it is well not to form the habit of seeing only the defects, for horses, like people, are seldom perfect, consequently in judging them weigh the good qualities against the bad. A horse should be valued by the amount of service he will perform rather than by his minor shortcomings.

PUBLICATIONS OF U. S. DEPARTMENT OF AGRICULTURE RELATING TO HORSES.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Principles of Horse Feeding. (Farmers' Bulletin 170.)
Horseshoeing. (Farmers' Bulletin 179.)
Breeds of Draft Horses. (Farmers' Bulletin 619.)
Colts: Breaking and Training. (Farmers' Bulletin 667.)
How to Select a Sound Horse. (Farmers' Bulletin 779.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Classification for American Carriage Horses. (Bureau of Animal Industry Circular 113.) Price, 5 cents.
Osteoporosis, or Bighead of the Horse. (Bureau of Animal Industry Circular 121.) Price, 5 cents.
Suggestions for Horse and Mule Raising in the South. (Bureau of Animal Industry Circular 124.) Price, 5 cents.
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The Computation of Rations for Farm Animals by the Use of Energy Values. (Department Bulletin 459.) Price, 5 cents.
Dourine of Horses: Its Cause and Suppression. (Bureau of Animal Industry Bulletin 142.) Price, 15 cents.
Horse and Mule Raising in the South. Price, 5 cents.
The Road Horse, with Special Application to His Selection and Management in Rural Delivery Service. (62d Cong., 2d sess., H. Doc. 906.) Price, 5 cents.
Special Report on Diseases of the Horse. Price, $1.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

CASTRATION OF YOUNG PIGS

FRANK G. ASHBROOK
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FARMERS' BULLETIN 780
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
A. D. MELVIN, Chief

Washington, D. C. November, 1916

LIST OF PUBLICATIONS OF U. S. DEPARTMENT OF AGRICULTURE RELATING TO HOGS.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Pig Management. (Farmers' Bulletin 205.)
Hog Cholera. (Farmers' Bulletin 379.)
Feeding Hogs in the South. (Farmers' Bulletin 411.)
Hog Houses. (Farmers' Bulletin 438.)
Boys' Pig Clubs. (Farmers' Bulletin 566.)
Feeding of Grain Sorghums to Live Stock. (Farmers' Bulletin 724.)
Breeds of Swine. (Farmers' Bulletin 765.)
How to Use Anti-hog cholera Serum. (From Farmers' Bulletin 590.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

The External Parasites of Hogs, being articles on Hog Louse (Hæmatopinus Suis), and Mange, or Scabies, of Hogs. (Bureau of Animal Industry Bulletin 69.) Price, 5 cents.
The Roundworms of Domestic Swine, with Special Reference to Two Species Parasitic in the Stomach. (Bureau of Animal Industry Bulletin 158.) Price, 10 cents.
Relative Proportions of the Sexes in Litters of Pigs. (Bureau of Animal Industry Circular 112.) Price, 5 cents.
The Danish Hog Industry. Price, 5 cents.
Inheritance of Fertility in Swine. (In Journal of Agricultural Research, Mar. 20, 1916.) Price, 15 cents.
The Control of Hog Cholera by Serum Immunization. Price, 5 cents.
Pasture and Grain Crops for Hogs in the Pacific Northwest. (Farmers' Bulletin 599.) Price, 5 cents.
The Boys' Pig Club Work. (Yearbook Separate 667.) Price, 5 cents.

CASTRATION OF YOUNG PIGS.

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This publication deals with castration, or the removal of the essential organs of male pigs. The objects of castration are to prevent reproduction, to increase fattening propensity, to better the quality of the meat of the animal, and to help insure docility. Every farmer should be competent to castrate pigs, as the losses from the operation are as a rule not very heavy and could be reduced by exercising care and attention.

AGE AT WHICH TO CASTRATE.

Pigs should be castrated while they are young; the best time is between 6 and 8 weeks of age, before weaning. At this age there is less shock to the pig and possibly less check in growth. If it is still sucking its dam when castration takes place the chances are that it will be more thrifty and in better condition than when the operation is performed immediately after weaning. A pig 6, 7, or 8 weeks old is small enough to be handled conveniently and the testicles are large enough to render the operation quite simple.

PREPARATION.

Select a clear, dry day to perform the operation; it should never be done on a rainy day. When it is possible to do so, avoid castrating during "fly time" or in extremely cold weather.

All the pigs that are to be castrated should be put into a pen just large enough to hold them, so as to facilitate catching and lessen the excitement among the animals. Another pen should be prepared to received the castrated ones. If they are to be kept in a house pen it should be clean, dry, and free from dust, and a small quantity of clean, dry straw should be scattered in it. If a pasture lot is to be used, select one that is free from mudholes and wallows and contains some grass.

A good castrating knife or a penknife that will keep a sharp edge is necessary to do a clean job. A castrating knife of this kind can be purchased for from $1.25 to $2. A roll of absorbent cotton and a vessel containing a 3 per cent solution of compound cresol (U. S. P.), carbolic acid, or other reliable disinfectant should be at hand.

METHOD OF OPERATING.

Two persons can work to the best advantage in castrating. The attendant goes into the pen and picks up a pig by the hind leg, taking the right hind and front leg in his right hand and the left hind and front leg in his left. In this manner the pig may be held in the lap of the attendant. If the attendant holds the pig in a position like that shown in figure 1 there is less liability of its wriggling about and making it hard for the operator to work. When the pig is in the desired position, the scrotum should first be washed with a piece of cotton saturated with the antiseptic solution (fig. 2), and before making the cut the operator should be sure that the knife and his hands are thoroughly clean. The knife should be dipped in the antiseptic solution before making the cut.

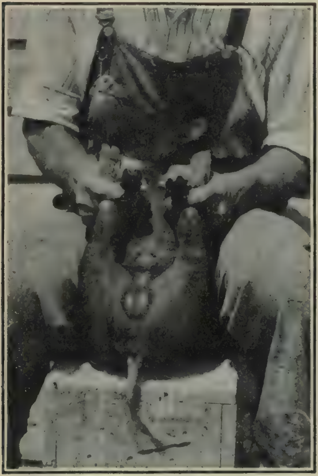

FIG. 1.—Method of holding pig for castration.

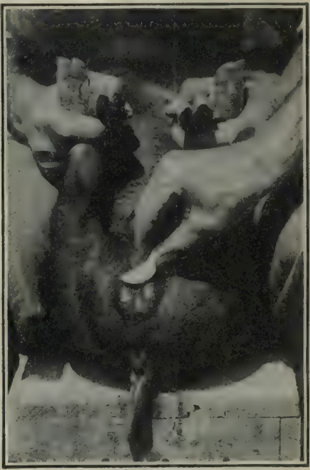

FIG. 2.—Cleansing the scrotum.

One of the testicles is seized between the thumb and forefinger of the left hand and an incision made over the most prominent part, parallel with the middle line of the scrotum and a half inch to the side of it. (Fig. 3.) The incision should be deep enough to liberate the testicle at one pass, and should also be long enough to free the testicle and to insure good drainage; to do this it must go through the scrotum and also through the sack that incloses the testicle. (Fig. 4.) The membranous sac is allowed to go back and should be cut loose at the inner part of the testicle so that the cords may be pulled out and scraped, not cut, off. The scraping is done by holding the knife in a slanting position and scraping back and forth until the cord is severed. (Fig. 5.) The cord should never be cut off abruptly, for to do so may cause a greater hemorrhage. Jerking out the cord is also dangerous, as it may cause a rupture. The other testicle is liberated in the same manner. (Fig. 6.) It is not necessary to sew up the wound, as it will heal more readily without interference.

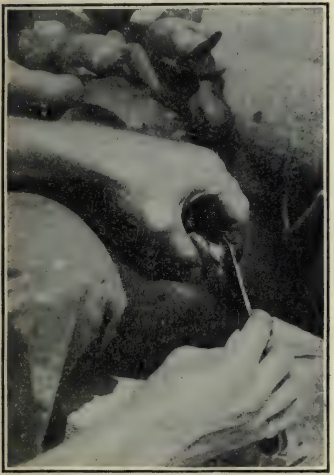

Fig. 3.—Making the incision.

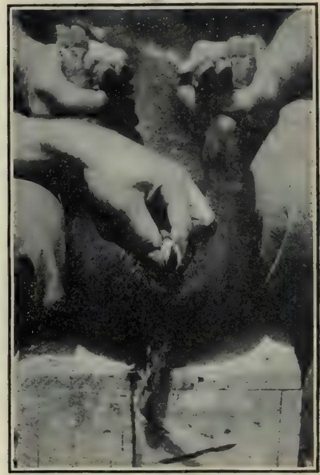

Fig. 4.—The testicle removed from the sac by one incision.

In hot weather it is advisable to rub some pine tar on the scrotum to keep flies and other insects from the wound. Accidents following castrations of pigs are rare, though abscesses are sometimes formed. These are manifested by much swelling and soreness at the seat of operation. Treatment consists in opening the abscess with a thoroughly clean knife and fingers, and washing it out twice daily with an antiseptic fluid.

PIGS RUPTURED IN THE SCROTUM.

There are on some farms from year to year numerous cases of pigs ruptured in the scrotum, while on other farms this condition is scarcely known. Some farmers castrate these pigs as readily as they castrate their ordinary boar pigs, but a great many others find the operation difficult or are unable to perform it.

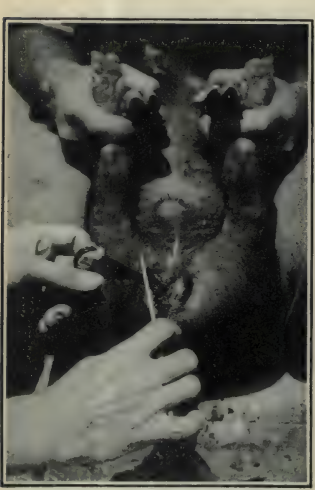

FIG. 5.—Scraping the cord.

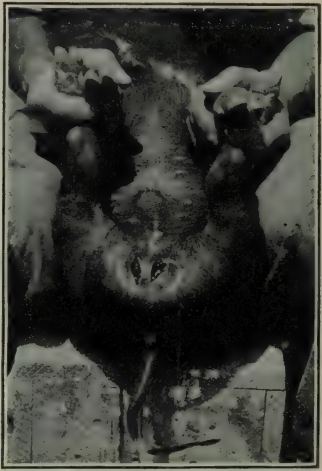

FIG. 6.—Incision after testicles have been removed.

The value of a pig in this condition is so slight that unless there is a considerable number of these ruptured pigs raised on the farm it will hardly pay the average farmer to employ a veterinarian to perform the operation.

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TUBERCULOSIS OF HOGS

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Tuberculous hogs, infected by working over a pile of manure from tuberculous cattle

FARMERS' BULLETIN 781

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
A. D. MELVIN, Chief

Washington, D. C. **May, 1917**

TUBERCULOSIS occurs among hogs in the United States to a serious extent and appears to be increasing. Nine per cent of all hogs slaughtered under the Government meat inspection during the fiscal year 1916 were found affected with this disease in some degree.

Tuberculous cattle are the main source of tuberculosis in hogs. The disease is most commonly conveyed by feeding hogs on unpasteurized skimmed milk and by allowing them to follow tuberculous cattle in the feed lot and feed upon the undigested grain in the droppings. It is very significant that tuberculosis is most common among hogs in sections where the disease is also most prevalent among cattle and where the feeding practices above mentioned are commonly followed. Hogs also contract tuberculosis from feeding on tuberculous carcasses of various animals, including fowls, and on uncooked garbage and slaughterhouse offal.

Prevention lies in the pasteurization of milk fed to hogs, especially that from creameries, and in allowing hogs to feed behind adult cattle only when the cattle have passed the tuberculin test; also in thoroughly cooking all garbage, offal, or carcasses before they are fed to hogs.

Young steers or young beef animals as a rule do not spread tuberculosis among hogs. Therefore no change need be made in the very profitable practice of allowing hogs to follow feeders and stockers, unless these cattle are not healthy.

When tuberculosis already exists in a drove of hogs all the affected animals, whether hogs or cattle, should be removed from the premises. The hogs should be sent to market for slaughter at an abattoir under Federal inspection. The tuberculin test should be applied to all cattle on the place, and those reacting should be properly disposed of. The pens and stables should be thoroughly cleaned and disinfected before restocking.

Hog raisers should be well posted as to the nature and prevalence of hog tuberculosis and how to prevent and get rid of it, so that financial losses may be avoided. This bulletin contains such information.

TUBERCULOSIS OF HOGS.

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PREVALENCE AND ECONOMIC IMPORTANCE OF THE DISEASE.

Tuberculosis in the human family has been lessening materially during the past 15 years, but reports from the various meat-packing centers of the country fail to show the same encouraging condition regarding tuberculosis in hogs. Reports from several localities during recent years show a decrease in the number of tuberculous swine sent to market, but the country at large shows an increase rather than a decrease in the number affected.

The swine industry of the United States has recently received great encouragement and stimulation from continued high prices paid for hogs. The average farm valuation of the hogs of the country for the decade 1900–1909 was $6.46, or $1.28 higher than during any decade in recent times, while the valuation since 1909 has been unprecedently high, ranging from $8 (in 1912) to $10.40 (in 1914). The small amount of money required to begin hog raising and the quick returns on the capital invested make this industry attractive to the small farmer. The hog will make a pound of gain on less feed than most live stock, and will profitably utilize waste food products.

Tuberculosis of hogs is closely associated with the same malady in cattle. The reason for this is apparent when one considers the close relations of these two species of domestic animals upon nearly every farm. Tuberculous cattle are the principal source of tuberculosis in hogs, the disease being transmitted readily by feeding hogs on unpasteurized dairy products and by allowing hogs to follow such cattle in the feed lot and feed upon the undigested grain in the droppings. Because of the early age at which hogs are slaughtered, they do not propagate the disease among their own kind to any appreciable extent. It is significant that tuberculosis of hogs most frequently occurs in localities where the disease is common in cattle.

NOTE.—This bulletin is a revision of Bureau of Animal Industry Circular 201, and is intended to assist hog-raisers in exterminating a dangerous disease.

The prevalence of tuberculosis among swine can be judged only from abattoir statistics. Of the hogs slaughtered during the fiscal year 1916 at establishments under the Federal meat inspection, 9 per cent were found to be affected with tuberculosis in some degree.

Records of the Bureau of Animal Industry show that some sections of the country contribute a far greater proportion of diseased animals than others. Hogs from Arkansas, Oklahoma, and Texas are remarkably free from this disease, owing probably to the method of caring for them, or rather the lack of caring for them. They are not confined in feed lots as in the sections where the disease is mostly found, but are allowed to roam over large areas of pasture and to shift for themselves, and when they are found affected the majority show very slight lesions. Furthermore, no prolonged feeding is practiced in narrow bounds as in the corn belt, and there are relatively few dairies or tuberculous cattle in these sections. The hogs are carried from birth to maturity on some form of pasture, as alfalfa, oats, corn, cowpeas, sorghum, rape, and peanuts, all the year round. There can be no doubt that swine fed entirely on vegetable feed, such as corn and roughage, are proportionately less affected than those fed on uncooked dairy products or behind diseased cattle.

A great many hogs in Texas are raised on alfalfa supplemented with corn, and the result is clearly shown in the bureau statistics, which indicate that during the fiscal year 1915 only 2.4 per cent of the 451,478 hogs slaughtered at Fort Worth showed tuberculous lesions. In striking contrast to this may be given the percentages for the same period of four cities in one of the leading dairy States, which show 9.0 per cent, 10.9 per cent, 12.1 per cent, and 25.1 per cent, respectively, of the hogs slaughtered to be affected with tuberculosis. There are a large number of cooperative creameries in the territory contiguous to the four cities alluded to, and the raw skimmed milk is taken home by the patrons for their hogs. Samples of separator slime from the two creameries in the town showing the largest number of tuberculous hogs were injected into guinea pigs, and in one instance virulent germs of tuberculosis were recovered.

From bitter experience the hog buyers for packing houses are gradually becoming familiar with these conditions and are avoiding certain regions known to be badly infected. Some packers are taking self-protective measures so as to have the feeder of diseased hogs bear the burden, and many of the smaller establishments in the Central West are buying hogs subject to post-mortem inspection.

It is very likely that many of the farmers who have sold tuberculous hogs have done so without suspecting that they were unsound, for few of these diseased hogs ever show the presence of tuberculosis by outward symptoms. In fact, the hogs that disclose the affection after slaughter are frequently the finest appearing animals in the drove. If indications of tuberculosis are present before slaughter they usually consist of marks of general unthriftiness, such as are also present in many other diseases, and therefore do not afford any very definite indication of the presence of tuberculosis. It is therefore important that hog raisers should know the facts about hog tuberculosis and how it may be prevented. The suppression of this disease would save the country many millions of dollars annually.

METHODS OF INFECTION.

The most frequent infection of hogs with tuberculosis occurs, no doubt, through the digestive tract, and in this mode of infection tuberculosis of cattle is very intimately concerned. In those instances in which a marked increase in the number of tuberculous hogs from a certain locality has been noticed and investigated it has too frequently been found that the hogs in question had been fed upon unpasteurized skimmed milk or that the carcass of some animal succumbing to tuberculosis had been thrown to them for final disposal. The certainty with which either of these two conditions will lead to the infection of the hogs has not heretofore been fully appreciated. Another source of infection for swine exists in the practice of allowing them to run behind tuberculous cattle and feed upon the undigested grain in the droppings. The tuberculosis germs discharged with the feces by such cattle may readily infect the hogs. Infection of a litter of pigs by a tuberculous sow presents another source of danger. There are a number of other methods of infection which will be mentioned later, but they should be considered of minor importance and must not detract attention from the leading factors in the production of the vast majority of cases of hog tuberculosis, which are unquestionably the milk and feces of tuberculous cattle. When once these are controlled tuberculosis of swine will forthwith be greatly reduced.

INFECTION THROUGH MILK OF TUBERCULOUS COWS.

Numerous experiments conducted by many scientists in various countries are in accord relative to the ease with which hogs may contract tuberculosis from being fed on milk of tuberculous cows. When hogs were fed on tuberculous milk for only 3 days the post-mortem examination held 107 days later showed that 83.3 per cent of the animals had become tuberculous. When hogs received tuberculous milk for 30 days and were allowed to live 50 days longer, 100 per cent of the animals had developed generalized tuberculosis.

That similar experiences occur under natural conditions on the farm has been proved by tracing certain shipments of tuberculous herds to the farm where they were raised and fattened. In one instance a shipment of 74 hogs showed tuberculosis in 61, and investigation brought out the fact that the swine had been fed on the skimmed milk of a creamery in a near-by town. The separator slime from two of the creameries in this town was obtained for experimental purposes, and the inoculation test showed that one of these samples produced tuberculosis in all the guinea pigs inoculated.

Centrifugal separators have come into general use. In the process of separating the cream from the milk the rapid revolutions of the shaft and disks of the machine deposit at the base of the shaft dirt, hair, manure, and other impurities, and, mingled with this mass, great numbers of bacteria, including at times the germs of tuberculosis.

The charge has been repeatedly made that the germs of tuberculosis are scattered by means of the common practice of distributing the separated milk or other by-products among the farmers who constitute the patrons of the creamery. To test this point careful search has been made of samples of the separator sediment from a number of creameries located in widely removed dairy regions to see if they really harbored virulent tuberculosis germs. When first received at the laboratory this material is examined microscopically. Following this examination all samples, whether showing the presence of suspicious bacteria or not, are injected into guinea pigs, where the presence of living tuberculosis germs is soon determined by the development of tubercular lesions. As a result of such an examination of the products from 15 creameries it has been definitely shown that 5, or 33⅓ per cent, of the samples examined contained virulent germs of tuberculosis.

There are no doubt many creameries to which no infected milk is delivered and from which the separated milk when divided among the creamery patrons is a safe and valuable article of food for calves and pigs. But there are, unfortunately, others, as above indicated, which receive milk daily from one or more cows so affected with tuberculosis that they give off the germs of that disease, and these germs find their way in large numbers into the cans of separated milk which are returned to the farmers from these creameries. In this way a single cow with a tuberculous udder may spread the disease to numbers of hogs, and may also infect many farms in a large section of country that have never been contaminated before with this destructive disease. This particular means of spreading tuberculosis could be absolutely prevented by cooking the milk, yet in the majority of cases this simple precaution is not taken.

In one State a lot of hogs which contained 36 per cent of tuberculous animals was traced to the farm of the raiser, and the State authorities were notified. They made a tuberculin test of the cattle producing the milk, with the result that about 22 per cent of them reacted. This infected milk had been separated on the farm with a hand separator and the skimmed milk fed to the hogs. It will thus be seen that creameries are not alone at fault, but the skimmed milk from the hand separator, if it comes from a tuberculous herd, is equally dangerous. The buttermilk produced at the creamery from the infected separated cream is likewise capable of carrying tuberculosis germs and infecting the animals which consume it.

The one great advantage from a hygienic standpoint which the milk from a hand separator has over the milk from a public creamery is that in the former case the milk from an infected herd is usually fed to only one lot of hogs. On the other hand the skimmed milk from the creamery is generally all mixed together in a vat and each farmer takes back with him his proportionate share of skimmed milk, which is most likely to be produced by several herds of other people's cattle. Hence the skimmed milk of but one tuberculous herd is liable, as a result of this practice, to contaminate the entire product of the vat into which it is placed. For this reason it behooves hog raisers to see that their skimmed milk has been properly heated before they feed it. Legislation making such heating by creameries compulsory affords a simple and easy way of greatly reducing hog tuberculosis.

INFECTION BY FECES OF CATTLE.

A very important source of infection of hogs with tuberculosis, and one which closely rivals tuberculous by-products from public creameries, is to be found in the feces of tuberculous cattle. It is a very common practice to allow hogs to accompany cattle about the feed lot, and while doing this they thoroughly work over the feces and feed upon whatever portions of food have passed undigested through the digestive tract of the cattle. (See illustration on front page.) In herds that are healthy this manner of feeding may be commended because of the economy, but wherever there are tuberculous individuals among the cattle the danger of passing the infection on to the hogs by means of the feces becomes very great.

In a series of investigations by the bureau it was found that the feces of tuberculous cattle are often loaded with tuberculosis germs. Tuberculin-tested hogs were placed in isolated pens where a few shovelfuls of such feces were thrown daily while the hogs were fed upon other feed which was free from tuberculosis. The result was the infection of 25 per cent of the first lot of hogs and 100 per cent of the second lot that were exposed. The tuberculous condition of the cattle was shown only by the tuberculin test, as they were apparently healthy, having no cough or any visible indications of disease.

A striking instance of probable infection of hogs by cattle feces came under observation. Of 34 hogs which were marketed in one lot 23 were found diseased, and upon investigation it was ascertained that the owner had a herd of dairy cows, the stable manure from which was thrown into the hog yard. The hogs were given no milk, nor were they permitted to mingle with the cattle, but were pastured and fed on corn and what they could gather from the cow manure. In fact, the latter form of exposure was the only plausible explanation of infection, and this was later accepted when the tuberculin test of the herd revealed 19 out of the 27 cows diseased. This test was confirmed when the cattle were slaughtered and found to be tuberculous, some in an advanced stage.

INFECTION THROUGH FEEDING ON TUBERCULOUS CARCASSES OR SLAUGHTERHOUSE OFFAL.

It is an all-too-prevalent custom in some sections for hog raisers to buy up all carcasses of animals that have died from various unknown causes and feed them uncooked to their hogs. This is a fertile source of infection with parasites and with any infectious disease that may have caused the death of the animals. Several instances of tuberculous hogs being traced to such an exposure have been found.

An equally dangerous source of infection is likewise observed in the methods which obtain among some of the small country slaughterhouses. It is not unusual for these houses to get rid of their blood, intestines, viscera, and other inedible parts by feeding them uncooked to hogs, a herd of which is usually kept on the premises. This custom is dangerous and is another method of spreading various infectious and parasitic diseases, and particularly a disease like tuberculosis. The feeding of offal, etc., to hogs on the premises of abattoirs having Government inspection is not permitted. As the slaughterhouses where hogs are fed in this manner have no Government inspection, this department has no records as to the number that become infected. Such hogs are killed by the butcher on the premises where they are fed, and are marketed as healthy meat.

TANKAGE DOES NOT PRODUCE TUBERCULOSIS.

It has been claimed that the increased use of tankage for hogs was the cause of the increase in the number of tuberculous hogs condemned at the abattoirs. The writers sent out inquiries to State experiment stations where tankage had been fed to hogs experimentally, to see if any case of tuberculosis had developed as a result of such feeding. Experiments were also carried on by this bureau along the same line. In no case could tuberculosis be shown to have arisen from the consumption of tankage, and it must therefore be freed from all blame in the spread of this disease, and may be looked upon as a safe and valuable article of food for use in raising and fattening swine.

Tankage, meat meal, and other animal food products are valuable for supplying the protein in a ration for swine, and have attracted attention from farmers because of the prevailing high prices of other foodstuffs. Tankage, or digester tankage as it is commonly called, is rich in protein and has proved a satisfactory substitute for skim milk as an adjunct to corn. It is made from the trimmings, inedible viscera, and other parts of the carcass, all of which are placed in the tanks and thoroughly cooked under pressure, so that the resulting product comes out sterile. The grease is removed from the surface and the residue is dried out at a high temperature, then ground, screened, and placed in 100-pound bags.

INFECTION FROM FEEDING UNCOOKED GARBAGE.

The feeding of uncooked city garbage to hogs is undoubtedly a factor in the development of disease. While there are no broad statistics obtainable concerning the prevalence of tuberculosis among garbage-fed hogs, there are records showing that animals fed upon such material contract diseases far more frequently than is the case with swine fed upon cooked garbage or other ordinary feeds. The most frequent sources of infection in garbage are tuberculous dairy products, sputum from tuberculous people, and the offal of tuberculous poultry.

At an establishment near Jersey City about 2,000 hogs are raised each season entirely upon garbage from hotels of New York. They are fed on cooked garbage exclusively, with the exception of a partial diet of dry or stale bread for a certain period before slaughter. In addition to the hogs thus raised and fed on the premises the firm slaughters a comparatively large number of hogs purchased from outside sources, either in odd lots from neighboring farmers or in car lots from shipping centers. These hogs do not come in contact with the hogs fed on the premises. When examined after slaughter they are found to be affected with tuberculosis in about the same proportion as is shown by the average of hogs inspected elsewhere. On the other hand, among the hogs raised exclusively upon sterilized garbage no indication of tuberculosis has been found when they were inspected at the time of slaughter.

The same firm has been engaged in this business for several years, and they state that after feeding the cooked garbage for some time they noticed a remarkable freedom from disease in the animals thus fed as compared with animals obtained from outside sources. Originally, their main object in cooking the garbage was the recovery of the valuable grease obtained therefrom, but they realize now the greater importance of the cooked product from the standpoint of the health of the animals fed upon this food.

From a sanitary standpoint there is no particular objection to the feeding of garbage to hogs provided that it is not accumulated and allowed to stand until putrefactive changes have taken place, and provided further that it is sterilized before it is used and that the containers are always kept clean. Sterilized garbage can be fed to swine with safety and is of great economic value. Piggeries where sterilized garbage is prepared and fed should be so constructed that they may be readily cleansed.

INFECTION BY TUBERCULOUS ATTENDANTS, TUBERCULOUS FOWLS, ETC.

The fact has been well established that hogs may contract tuberculosis through eating the sputum of consumptives. Proper precautions in selecting caretakers for farm animals will prevent the occasional infections from this source.

The Bureau of Animal Industry has investigated a case in which a large proportion of the hogs shipped from a certain ranch were found to be tuberculous when examined at the packing house, while at the same time it was learned that practically all the poultry on the farm had the disease to a serious degree. It was learned that it had been the custom at this place to throw all of the dead hens over into the hog yard, where they were greedily eaten. A pair of tuberculous hens from this affected farm were shipped to the bureau laboratories and were fed to a pair of healthy pigs 2 or 3 months old. The result was that both pigs became tuberculous. The frequent association of pigs and fowls makes it desirable to eradicate the disease from among the fowls, should it exist, before attempting to clean up the hog quarters.

Tuberculosis may be transmitted from hog to hog, especially from a tuberculous brood sow to her pigs, but this manner of infection is quite infrequent compared with the number of cases that can be traced to tuberculous cattle.

SYMPTOMS OF TUBERCULOSIS IN HOGS.

Where the disease has progressed to an advanced stage various symptoms may appear. Intestinal tuberculosis is frequently accompanied by general disturbance of the digestive functions, and constipation or diarrhea may be shown. Advanced tuberculosis of the lungs will be shown by a persistent, dry, harsh cough, and by rapid breathing, especially on exercise. This cough is similar to that caused by lungworms and can not be distinguished from it.

Interference with both respiratory and digestive functions may be seen when the disease is widely generalized, and the numerous alterations will be shown by progressive emaciation and weakness. Localized centers of the disease in bones or joints may produce lameness and other visible indications, but these are comparatively very rare.

In the majority of cases no intimation of the presence of the disease will be given until the animal is slaughtered, and the discovery of a number of tuberculous hogs in a drove of apparently prime, well-finished animals is often the cause of great surprise and disappointment to their owner. In such cases the lesions may be sufficient to prove the disease far advanced and the germs to be so widely distributed as to render the meat unfit for food.

In those cases where the disease is not characterized by prominent symptoms, but where the animals are suspected of having the disease, the tuberculin test is recommended. This makes it possible to slaughter the reacting animals in the early stages of the disease and thus get rid of the infection. This is especially important in holding over brood sows, as experiments have indicated that the milk of these sows may infect the young pigs.

THE TUBERCULIN TEST.

The intradermal method of applying the tuberculin test has been tried on hogs, and has given excellent results. Two drops of tuberculin prepared by evaporating away two-thirds of the volume of the tuberculin prepared by this bureau for the subcutaneous tuberculin testing of cattle, is injected into but not under the skin near the base of one of the ears of the hog. If the animal is not affected, no change in the appearance of the ear will result, but a positive reaction will at the end of 48 hours cause a swelling near the seat of injection, as shown in figure 1. This enlargement may remain visible for 10 or 12 days after the injection in case the animal is affected with tuberculosis.

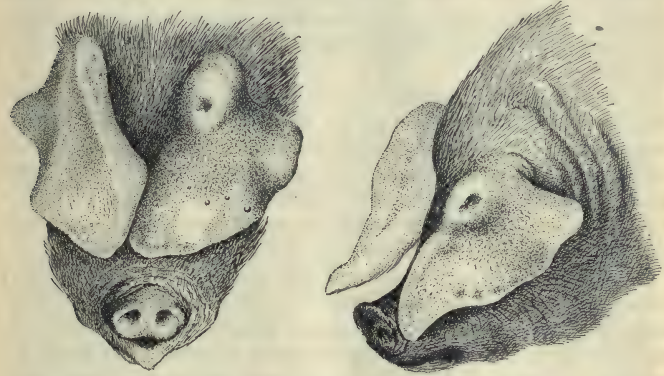

FIG. 1.—Tuberculin test for hogs, intradermal method, showing enlargement at seat of inoculation due to positive reaction. (After Moussu.)

LESIONS.

The vitality of hogs or their powers of resistance to disease are necessarily lowered by the unnatural conditions which frequently obtain in hog raising, namely, the forced feeding for fattening and the small feeding pens in vogue in certain districts. When the enormous growth of a hog is considered, when it is realized that in the short space of 8 to 10 months its development is frequently 250 to 300 pounds—a proportionate increase of weight unknown to any other species of domestic animals—the great changes which must necessarily occur can be appreciated. Such rapid development is very likely to take place at the expense of the disease-resisting powers of the animal.

When tuberculosis results the lesions usually observed are distinct and of a chronic type, as manifested by lime-like deposits and fibrous walls. It is not infrequent, however, that a more extensive and spreading disease is seen, and the lesions indicate a severe infection and rapid diffusion of the germs or bacilli, which in these animals may quickly follow the initial attack. And whether the disease assumes an acute, subacute, or chronic type, tuberculous growths may soon be found attacking lymph glands in widely separated parts of the body.

As a general rule, the lymph glands become enlarged, and a cheese-like change occurs at several points where the tubercles had started, causing numerous small yellowish areas often surrounded by a reddened, inflamed zone. These areas are composed of broken down gland substance, and are sometimes intermingled with pus; at other times they are of a cheesy consistency, and more frequently gritty through the deposit of limelike particles.

As the disease is produced essentially by feeding, the glands and tissues associated with the digestive tract are the most frequent seats of infection. Indeed, the throat glands (in almost all cases the submaxillary gland) are nearly always affected, as at the post-mortem examinations held by bureau inspectors over a consecutive period on 120,000 tuberculous hog carcasses, 93.3 per cent were found to contain lesions in these glands. Next in importance are the bronchial glands, of which 27.2 per cent were diseased, while the chain of liver glands was involved in 21.6 per cent of the cases. In all these cases the lesions may involve the entire lymph structure, or only the central or several irregular points, and may be either cheeselike, limelike, or both. The intestinal lymph glands showed lesions in 18.1 per cent of the carcasses examined.

The liver was affected in 9.2 per cent of the cases and showed either yellowish points, which were cheesy and scattered, not only on the surface but also within the organ, or the larger, irregular nodules, varying from a hemp seed to a hickorynut in size. They are at times quite fibrous in consistency and may contain a cheesy center, or limelike deposits may occur as the disease advances and the lesions

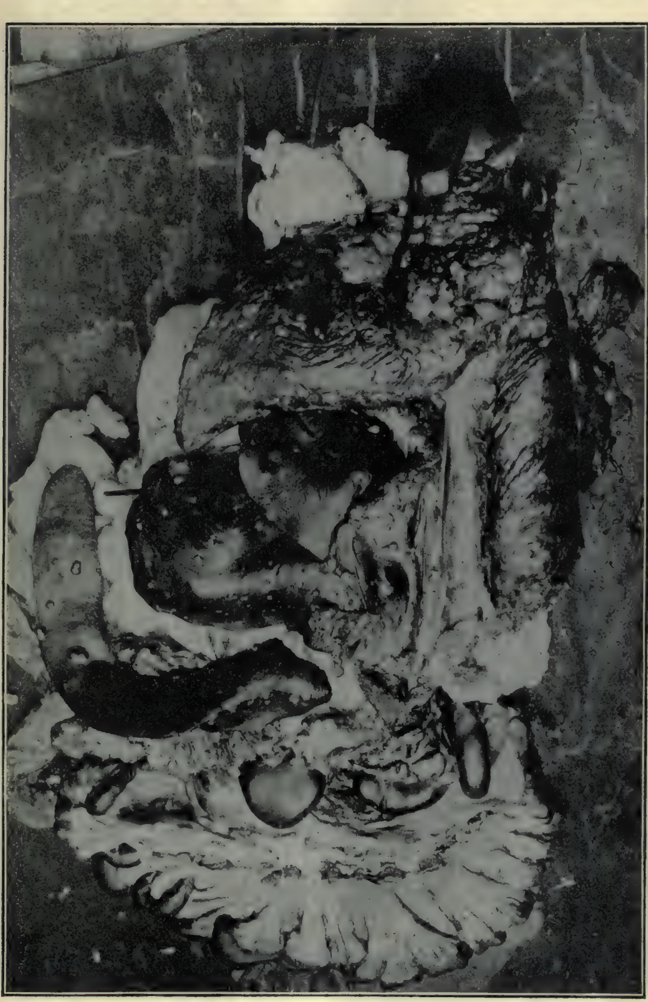

FIG. 2.—Tuberculosis of hog, involving the lungs, liver, spleen, and intestines.

become more considerable. The lungs are the next tissue to be most frequently affected, as is represented by 7 per cent of the carcasses

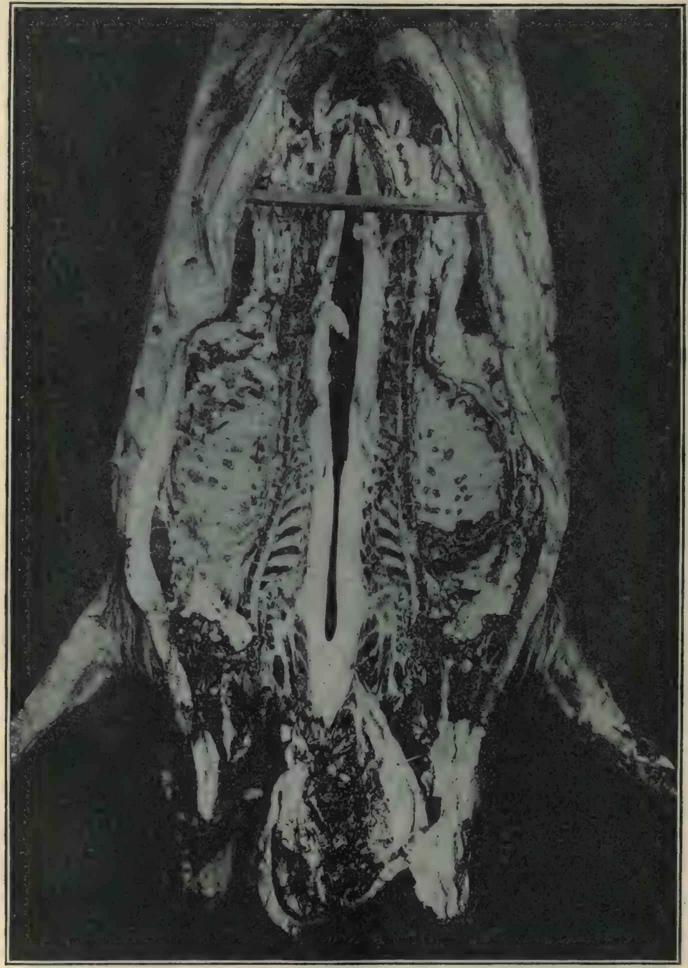

FIG. 3.—Tuberculous hog carcass, showing tuberculous nodules on the ribs.

above recorded. There may be tuberculous pneumonia involving large areas of the lungs, causing collapse of the borders. There may be irregular-sized grayish or yellowish areas, as is so often seen in cattle; but not infrequently there are observed large numbers of shot-like areas, showing evidence of general disease.

The spleen showed lesions in 3.8 per cent of the carcasses above mentioned. The spleen is usually darker in color and the surface is quite rough and nodular, depending upon the number and size of the tubercles. Unlike the spleen of a tuberculous cow, these nodules not often occur on the outside membrane. They vary from the size of a half pea to as large as a hickorynut. The external pale or light-red nodules are raised above the surface of the organ and frequently show fibrous tissue bands radiating from the center.

Occasionally lesions similar to those found in other glands are noted in the mediastinal and sublumbar glands. In occasional cases the membranes lining the body cavities may show an eruption of tuberculous nodules. The generative organs are rarely affected. The bones are sometimes attacked. Tuberculosis of the muscles has been noted, but not so frequently as of the bones and joints. These lesions are usually rather limited to one region. The extreme rarity of lesions in the kidney is shown by the finding of but 3 cases in the 120,000 tuberculous carcasses.

Occasionally also ulcers and tuberculous nodules are noticed on the lining of the small intestines, especially of young pigs, but these likewise are rare, and when found usually accompany numerous lesions elsewhere in the body.

PREVENTIVE MEASURES.

REMOVAL OF AFFECTED ANIMALS.

The first step to be taken in preventing the further spread of tuberculosis is to remove all affected animals, whether hogs or cattle, from the premises, as these will only serve as sources of infection so long as they are allowed to mingle with healthy animals. In dealing with affected herds of cattle it has been found best in most cases to apply the tuberculin test to the entire herd as a means of selecting the tuberculous animals, but with a drove of hogs in which tuberculosis has spread there can be no doubt that the best and surest method of procedure will in nearly every case be found in the slaughter of the entire drove as soon as they can be put in a marketable condition. They should be slaughtered at an abattoir under Federal inspection, so that proper disposal may be made of affected carcasses. A farm may be stocked rapidly with healthy swine after the total slaughter of a tuberculous lot. The early age at which the sow may be bred, her capacity for breeding twice a year, and the plural number of her offspring are forceful arguments for the total destruction of every diseased drove of hogs and the breeding up in clean, healthy quarters of a sound, healthy drove in its stead.

As tuberculosis seldom attacks the hogs of a farm except through tuberculous cattle, the tuberculin test should be applied to all of the cattle on the place, and all tuberculous animals among them should be isolated or destroyed at the time of disposing of the hogs.

In case the disease has only recently been introduced among the hogs it would be advisable to apply the tuberculin test to them so that the affection may be detected in the early stages. By slaughtering only the reacting hogs and saving the healthy ones the hog raiser may clean up his herd with as little loss as possible.

DISINFECTION.

With the hogs all removed from the place and no tuberculous cattle remaining, attention should next be given to disinfecting the premises, so that no center of infection may be left to contaminate future purchases of live sock. The disinfection of pens and stables may be accomplished by thoroughly cleaning them, scrubbing the floors with hot water, brushing down all loose dust from the walls, and tearing out all woodwork which has become partly decayed. The interior of the pens or stables should then be carefully covered with a coating of lime wash containing 4 or 5 ounces of compound solution of cresol (U. S. P.) to each gallon of the lime wash.[1] The yards should be carefully cleaned at the same time, especial attention being given to the removal of all rubbish and litter from the dark, shady corners. Lime, or a 3 per cent solution of carbolic acid, may then be sprinkled upon these dark portions of the yards. In all of the open portions of the yard the action of the direct rays of the sun will very quickly destroy the life of the scattered tuberculosis germs.

The premises now being cleaned, healthy foundation stock may be procured, and if proper attention is given to keeping the cattle of the farm free from tuberculosis and to supplying the hogs with suitable food, the owner may feel every reasonable assurance that he has seen the last of tuberculosis among his swine. The trouble, time, and expense required will be more than repaid by the advantages gained.

Tuberculosis can not develop spontaneously in swine but must be acquired from some outside source, and the farmer whose yards and stables have been thoroughly freed from the disease need fear no reappearance of the disease, except when introduced from some outside point of infection.

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[1] More detailed information is given in Farmers' Bulletin 345, "Some Common Disinfectants," and Farmers' Bulletin 480, "Practical Methods of Disinfecting Stables," issued by the United States Department of Agriculture.

PASTEURIZATION OF ALL MILK PRODUCTS USED FOR FEED.

The heating of all milk when received at public creameries to 145° F. for 30 minutes or to 176° F. for a moment will be found most effective in preventing the spread of tuberculosis to the animals consuming the by-products of such creameries. Denmark was one of the pioneers in this movement, having in 1898 passed a law requiring all skimmed milk and all buttermilk to be warmed to 185° F. before it could be distributed from any creamery to its patrons for feeding purposes. It was found, however, that this degree of heat was harmful to the product, and in 1904 the required temperature was reduced to 176° F., experiments having proved that no tuberculosis germs could withstand this amount of heat. In practically all of the Danish creameries from this latter date the whole milk has been heated to the required point, thus assuring butter that is free from tuberculosis germs, as well as by-products that are safe for use in feeding hogs or calves. The result of these regulations has been most satisfactory. The spread of tuberculosis to farms previously free, through the skimmed milk or the buttermilk from creameries, has been very markedly checked and suppression of the disease in hogs has been plainly noticeable.

Treating of creamery milk as a cause of the spread of tuberculosis among hogs, Moussu, a French investigator, makes the statement that cooking the by-products of creameries and cheese factories results in the disappearance of tuberculosis of an intestinal origin among the hogs fed with them, and the hog owners no longer fear losses from this disease.

Borgeaud has cited an instance in which a serious outbreak of tuberculosis among hogs in Switzerland was overcome by boiling all of the separated milk before feeding it to the subsequent litters of young pigs.

LOCATING AND REMOVING CENTERS OF INFECTION.

The Bureau of Animal Industry is endeavoring to locate infected farms, or at least infected localities, and to ascertain the direct cause of the spread of the disease in these districts. Owing to the number of hands through which hogs go before reaching the abattoirs this is not easy, but it can be and is being accomplished. Already, through cooperation with the State authorities, a large number of infected farms have been definitely located. The conditions on these farms have been investigated, the source of the disease determined, and methods for its suppression recommended. Both the bureau and State officials have been working with these ends in view. When hogs have been found to be tuberculous when slaughtered under the

Federal meat inspection and the farm from which they came has been located, the State veterinarian is notified. In most States this officer is empowered by law to quarantine any farm when he suspects the presence of a contagious disease thereon. He then applies the tuberculin test to the cattle on the farm and otherwise looks for the source of infection. This frequently results in finding the cattle tuberculous.

This cooperation with the State is of great value, and the results would be greater if State legislation were enacted compelling the tagging of all hogs going to slaughter, so that these animals if found tuberculous could be immediately traced to their point of origin and the source of infection removed.

SPREADING INFORMATION AMONG FARMERS AND DAIRYMEN.

While pamphlets, popular articles, and public notices would be extremely useful in eradicating tuberculosis in swine, it would probably be more satisfactory to explain to the hog raiser by word of mouth the methods to be followed. The veterinarian is the best equipped man available for the work. The State might also assist by employing veterinarians to give public lectures in towns and townships, as is being done at present in Sweden. There is now absolute knowledge that the vast majority of cases of hog tuberculosis are produced by—

1. Raw milk and slime from creameries.
2. Hand-separated milk from tuberculous cattle.
3. Feeding behind tuberculous cattle.
4. Feeding tuberculous carcasses of various animals, including fowls.
5. Feeding slaughterhouse offal.
6. Feeding uncooked garbage.

It therefore behooves veterinarians to educate their clients as to the proper method of preventing this disease, as they would recommend a proper feeding ration or proper construction of a stable. Hog raisers should (1) scald all raw products returned from the creamery; (2) have their cattle tested with tuberculin if a hand separator is used on the farm, or, in the absence of such a test, to scald the skimmed milk; (3) let the hogs feed behind healthy cattle only, or those which have passed the tuberculin test; (4) feed carcasses of animals that have died from any cause, or offal from the slaughterhouse, or garbage of any character, only after the meat, offal, or garbage has been thoroughly cooked.

Sooner or later the packer and slaughterer are going to buy hogs subject to the post-mortem inspection, as they are at present doing in some of the large packing centers with certain classes of female cattle; and the hog raiser who continues to fatten his hogs with tuberculous material should be made to sustain the losses arising from his lack of knowledge, skepticism, or indifference. The innocent purchaser, who can not be familiar with the methods of feeding on the farms of the different breeders, should not be expected to bear such losses, nor should the intelligent hog raiser who produces healthy hogs by carrying out minutely the known and proved methods of prevention be obliged to bear a portion of the burden caused by the careless hog raiser, as is the case at present. To-day the hog buyer must make his purchases with the absolute knowledge that a certain proportion of his purchase will be condemned for tuberculosis, and as the post-mortem examination is the only key to the extent of the disease, the careful breeder must suffer equally with the careless one. This is not equitable. When the packer buys subject to the post-mortem results the intelligent hog raiser will get more for his healthy hogs than he does now, and the careless breeder will get less for his tuberculous hogs, which is as it should be.

Extermination of hog tuberculosis is practicable, relatively easy, and should be attained without delay before the disease has gained too much headway.

LIST OF PUBLICATIONS OF U. S. DEPARTMENT OF AGRICULTURE RELATING TO HOGS.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Pig Management. (Farmers' Bulletin 205.)
Hog Cholera. (Farmers' Bulletin 379.)
Feeding Hogs in the South. (Farmers' Bulletin 411.)
Hog Houses. (Farmers' Bulletin 438.)
Boys' Pig Clubs. (Farmers' Bulletin 566.)
Breeds of Swine. (Farmers' Bulletin 765.)
How to Use Anti-hog-cholera Serum. (From Farmers' Bulletin 590.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Chemical Composition of Carcasses of Pigs. (Bureau of Chemistry Bulletin 53.) Price, 5 cents.

The External Parasites of Hogs, being articles on Hog Louse (Hæmatopinus Suis), and Mange, or Scabies, of Hogs. (Bureau of Animal Industry Bulletin 69.) Price, 5 cents.

The Etiology of Hog Cholera. (Bureau of Animal Industry Bulletin 72.) Price, 25 cents.

The Bacteriolytic Power of the Blood Serum of Hogs. (Bureau of Animal Industry Bulletin 95.) Price, 10 cents.

Filtration Experiments with Bacillus Choleræ Suis. (Bureau of Animal Industry Bulletin 113.) Price, 10 cents.

The Roundworms of Domestic Swine, with Special Reference to Two Species Parasitic in the Stomach. (Bureau of Animal Industry Bulletin 158.) Price, 10 cents.

Relative Proportions of the Sexes in Litters of Pigs. (Bureau of Animal Industry Circular 112.) Price, 5 cents.

The Danish Hog Industry. Price, 5 cents.

Embryonal Adenosarcoma of the Kidney in Swine. Price, 5 cents.

Inheritance of Fertility in Swine. (In Journal of Agricultural Research, March 20, 1916.) Price, 15 cents.

The Control of Hog Cholera by Serum Immunization. Price, 5 cents.

Field Tests with Serum for the Prevention of Hog Cholera. (In Bureau of Animal Industry Report, 1908.) Price of entire volume, cloth, 70 cents.

New Facts Concerning the Etiology of Hog Cholera. (In Bureau of Animal Industry Report, 1903.) Price of entire volume, cloth, 50 cents.

Pasture and Grain Crops for Hogs in the Pacific Northwest. (Farmers' Bulletin 599.) Price, 5 cents.

The Boys' Pig Club Work. (Yearbook Separate 667.) Price, 5 cents.

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THE USE OF A DIARY FOR FARM ACCOUNTS

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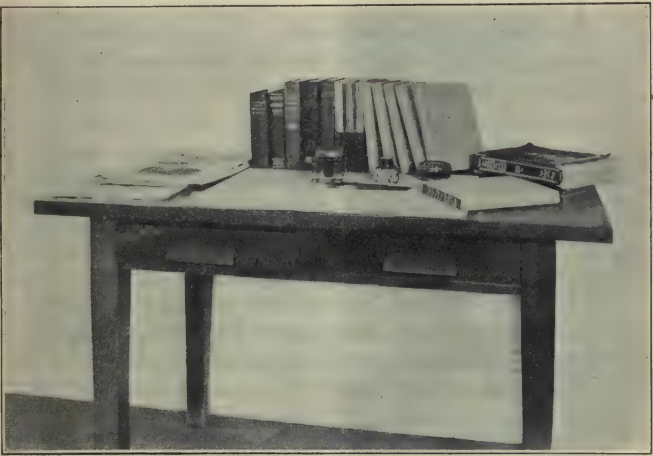
Assistant Chief



FARMERS' BULLETIN 782

UNITED STATES DEPARTMENT OF AGRICULTURE

Office of the Secretary

Contribution from the Office of Farm Management

W. J. SPILLMAN, Chief

Washington, D. C. January, 1917

THIS BULLETIN tells how a diary may be used for keeping certain farm records. Farmers have need of two kinds of accounts, first, those in which are recorded items of a financial nature, such as receipts and expenditures, and, second, those in which are kept records of farm work and production, such as dates of planting and of harvesting, crop yields, feeds fed to live stock, etc. On the average farm, where the business is not too large, a diary is a very convenient means of keeping all these records.

The farm home and the farm business are intimately associated; the one is indeed the headquarters of the other. A carefully kept diary embodies a chronicle of the affairs of both which is of permanent value, not only from a personal and sentimental standpoint, but also as a continuous record of the farm business.

In the following pages several different kinds of such diaries are described with suggestions as to how various farm accounts may be kept in diary form.

THE USE OF A DIARY FOR FARM ACCOUNTS.

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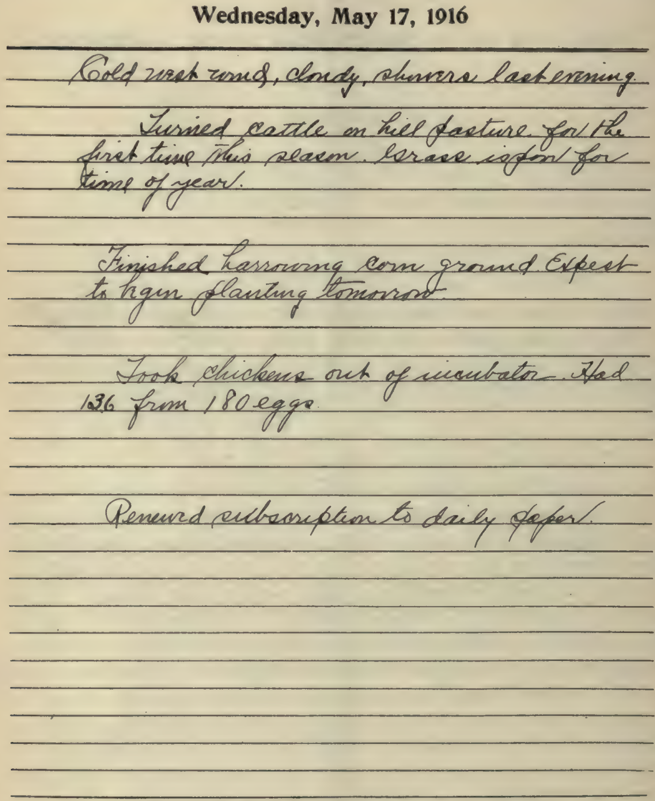
Many farmers have found a diary more or less helpful for keeping a record of their farm operations. Some farmers use it merely to record the daily happenings of the farm or those of a personal nature, while others use it to keep a fairly complete record of their farm business. The possibilities of the diary for farm accounting are not generally understood. With a little care and thought its value for this purpose can be greatly increased.

A successful New York farmer kept a diary from the time when he began farming as a young man until he retired recently after 40 years of active farm work. In these diaries he has a record of all farm operations, the machines used, the dates of planting and harvesting, the yields of crops, and daily notes on the weather. In the back of each diary is a financial account of his farm business, giving the amount of products sold, with prices, a list of all expenses, and a memorandum of transactions with his neighbors. Aside from all the strictly business items, there are daily notes of personal interest, of plans and ambitions, and of neighborhood happenings, which in themselves make a valuable record. Thus the value of these diaries to him lies not only in the practical farm accounts, but also in the pleasures of reminiscence he derives from reading their pages. For years his farm neighbors have looked to him and his diaries to settle arguments as to the date when certain events happened in the community.

The one important essential in which a diary differs from ordinary bookkeeping records is that it contains items of a personal as well as of a business nature. It holds the farmer's interest, whereas farm accounts without the accompanying diary become in a few years dry reading.

It is the purpose of this bulletin to explain the different types of diaries available and the methods of utilizing them for farm records, attention being given to a discussion of such accounts as can readily be kept in a farm diary and which will be found of value to the average farmer.



Wednesday, May 17, 1916

Cold west wind, cloudy, showers last evening.

Turned cattle on hill pasture for the first time this season. Grass is poor for time of year.

Finished harrowing corn ground. Expect to begin planting tomorrow.

Took chickens out of incubator. Had 136 from 180 eggs.

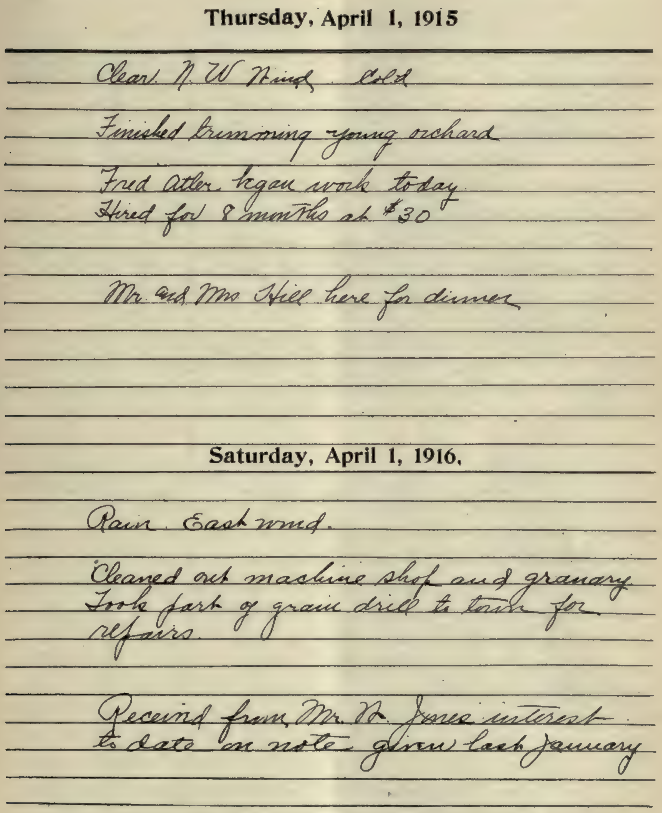
Renewed subscription to daily paper.

FIG. 1.—Typical page of diary used for farm records.

TYPE OF DIARIES.

The most common form of diary is a book containing a blank page for each day's record and space in the back of the book for financial accounts. Most diaries of this kind are similar in arrangement and vary in price according to the quality of paper and the binding. (See fig. 1.)

Another form of diary has a page for each day divided to provide space for two successive years' records. A similar type provides space on each page for five successive years' records. Neither of these forms is in as common use as that illustrated in figure 1. They are designed primarily for a memorandum of work and do not appear to be well suited to the farmer's use. (See fig. 2.)



Thursday, April 1, 1915

Clear. N. W. Wind. Cold

Finished trimming young orchard

Fred Atler began work today
Hired for 8 months at $30

Mr. and Mrs. Hill here for dinner

Saturday, April 1, 1916.

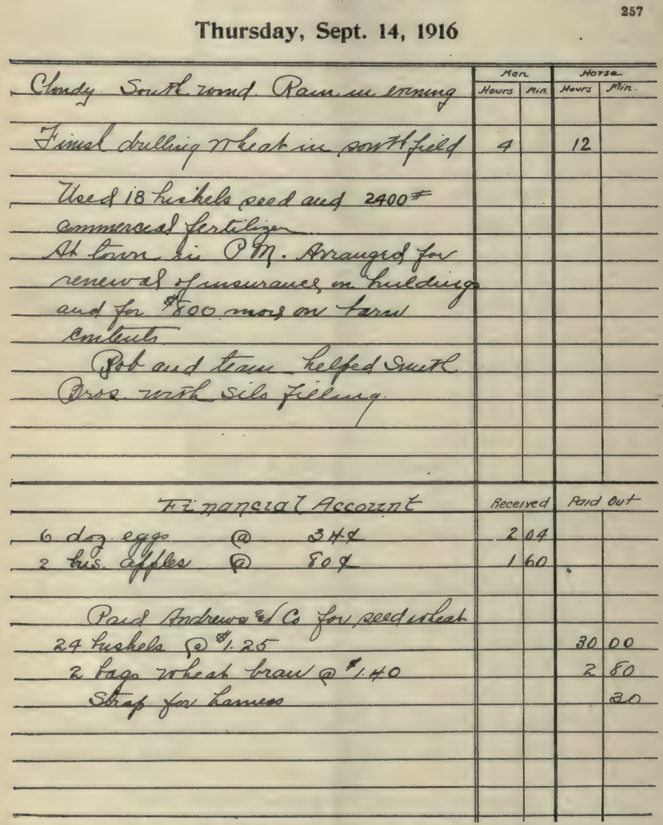
Rain. East wind.

Cleaned out machine shop and granary.
Took part of grain drill to town for
repairs.

Received from Mr. N. Jones interest
to date on note given last January

FIG. 2.—Form of diary designed for two years' records.

A blank book sometimes called a "daily journal" may be used for a diary and for farm accounts. This book, with a page for each day, contains space enough for notes and records of the farm work, and for a memorandum of financial transactions at the bottom of the page. (See fig. 3.) This arrangement permits having on one page a complete record of each day's farm business. With some extra pages in the back for the farm inventory and summary, this book can easily be used to keep a financial record of the ordinary farm business.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Thursday, Sept. 14, 1916

	Man Hours	Man Min.	Horse Hours	Horse Min.
Cloudy. South wind. Rain in evening				
Finish drilling wheat in south field	4		12	
Used 18 bushels seed and 2400# commercial fertilizer.				
At town in P.M. Arranged for renewal of insurance on buildings and for $800 more on farm contents.				
Rob and team helped Smith Bros. with silo filling.				

Financial Account	Received		Paid Out	
6 doz. eggs @ 34¢	2	04		
2 bu. apples @ 80¢	1	60		
Paid Andrews & Co for seed wheat 24 bushels @ $1.25			30	00
2 bags wheat bran @ $1.40			2	80
Strap for harness				30

FIG. 3.—Sample page of a diary with two columns on the right, used for a memorandum of farm work and of financial transactions.

No diary is really practical for complete accounts of a large farm business where extensive records are necessary. On the other hand, a diary used as a memorandum will be a very useful supplement in furnishing information ordinarily omitted from financial records.

SUGGESTIONS FOR KEEPING A DIARY.

It takes time to learn how to keep a diary in a way that will be most useful. Good judgment must be exercised in the selection of what items are worth mentioning. No rules are possible, as each individual must be guided according to his own interests. It is a fine art to distinguish between those things which are of interest only for the present and those thoughts and actions the recollections of which will be cherished in after years. It is important to write the records regularly, counting it a part of the daily farm work. Be careful not to make the records too general in character, since then each day's record will tend to be like any other. Be specific, and never let a day go past without putting down something. No day is so idly spent that it has no thought or action worth mentioning.

Whatever form of diary is used it should be of good size, of a good grade of paper, and strongly bound. A suitable one can usually be purchased for from $1 to $2. It will not pay to use a book of inferior binding or paper, as part of the satisfaction of keeping the records is having them in good, permanent form. Records should be written in ink, as lead-pencil writing will become dim after a few years. A fountain pen will be found very useful in this connection.

ACCOUNTS FOR FINANCIAL SUMMARY OF THE FARM BUSINESS.

The prime essential in keeping farm accounts is to ascertain at the outset what records are necessary to give the desired information about the farm business. With this clearly in mind the actual keeping of the records becomes a very simple matter. Generally speaking, there are three specific purposes in keeping farm accounts:

(1) To determine the farm investment, receipts, and expenses and thereby the net income from the farm business as a whole.

(2) To determine the net returns from any individual farm enterprise, but more especially to furnish specific information, such as amount of feed fed to each kind of live stock, amount of milk or number of eggs produced, and in the case of crops to show the efficiency of the methods used in the production of each.

(3) To furnish a memorandum of what other people owe you and what you owe other people.

Investigations show that fully 40 per cent of all farmers keep some kind of accounts. The great majority of these attempt only a record of receipts and expenses. This probably is the most important, for much depends on a knowledge of the income and outgo of the entire farm business.

The following outline shows what accounts are needed aside from the farm inventory to complete this financial summary of the farm business. Each of these accounts is taken up more in detail in the succeeding paragraphs and explanations are given as to how they can be kept in a diary.

OUTLINE OF FINANCIAL SUMMARY OF THE FARM BUSINESS.

Inventory of farm investment	Real estate. Live stock. Feed and supplies. Machinery and tools. Cash to run the business.
Receipts	Increase, if any, in value of live stock during year. Increase, if any, in amount of feed and supplies. Sales from crops. Sales from live stock. Sales from live-stock products. Miscellaneous.
Expenses	Decrease, if any, in value of live stock during year. Decrease, if any, in amount of feed and supplies. Live stock purchased. Current (labor, feed, repairs, etc.). Depreciation of buildings and machinery.

Farm income or difference between receipts and expenses
Interest on farm investment
Farmer's labor income

Farm home supplies not counted in above statement.

Rental value of farm dwelling
Garden products, fruits, etc
Meats, eggs, milk, etc

Total furnished by farm

It may seem odd to speak of the farm summary in the beginning of the discussion on what accounts to keep. The reason for this is that the summary is used to construct the accounts, just as the architect's plan is used to construct the building. In other words, one can not tell what accounts to keep until he has looked at the plan of summarizing and learns what accounts are needed.

FARM INVENTORY.

The inventory, or list of farm property at the beginning and end of the year, is one of the most important features of any form of farm accounting. Such a record is also of great value in adjusting insurance in case of fire. It should be made either in the winter or early spring prior to the commencing of spring work.

An extra blank book, devoted entirely to annual inventories, will prove helpful when diaries are used for the other accounts. Such a book, which might be called an inventory or property book, could be ruled to permit grouping all the values of any article for a period of years. It will save copying the items into each year's diary. The following is a sample page from such a book:

HORSES.

Name.	Age.	Value.						
		1910	1911	1912	1913	1914	1915	1916
Jess. (Bought in March, 1908)	4	200	200	225	225	215	215	200
Kit. (Died April, 1913)	11	150	140	130	120			
Jack. (Bought June, 1912, age 5)	5				175	180	200	200

Real estate.—Under the heading of real estate is included the value of land, buildings, fences, woodlot, and all other items of a permanent nature. These are not itemized separately, as the farm is thought of as a unit made up of land, buildings, and other permanent improvements.

Live stock.—Form I is for the live-stock inventory. Space is left for entering only the total for each class of animals. If desired, however, the individual animals in each class can be valued separately, using an extra book or blank pages in the back of the diary for this purpose.

FORM I.—*Statement showing summary of live-stock inventory.*

Animals—kind.	Beginning of farm year.			End of farm year.		
	No.	Value.	Total.	No.	Value.	Total.
Cows						
Heifers						
Calves						
Bulls						
Steers						
Oxen						
Horses						
Mules						
Colts						
Ewes						
Lambs						
Brood sows						
Other hogs						
Pigs						
Chickens						
Turkeys						
Ducks						
Bees						
Total						

Feed and supplies.—It is sometimes difficult to estimate closely the amount of feed and supplies of various kinds on hand and to determine the proper value for same. Yet this is important, in that much of the income of the farm may be in the form of grain or roughage held for feed. When the total of these items is more at the end of the year than at the beginning it represents a gain and is counted as a receipt; when less at the end of the year, an expense. Grain and hay held for sale are not included in this group, but should be listed under receipts from crops sold at values prevailing at the time of taking the inventory. Care must be used in listing the items to include all farm supplies, such as binding twine, fertilizers, machine oil, lumber, etc.

Machinery and tools.—A suggestive list of some of the more common implements is given in Form II. It is time well spent to go through the buildings each year and make a list of the machines and tools, using the best judgment possible in placing the values on different articles.

FORM II.—*Statement showing list of machinery.*

LIST OF MACHINERY.

No.	Kind.	Value at beginning of year.	No.	Kind.	Value at beginning of year.
....	Heavy wagons..........	....	....	Mowing machine..........	....
....	Light wagons..........	....	....	Hayrake..........	....
....	Pleasure wagons..........	....	....	Tedder..........	....
....	Sleighs..........	....	....	Hay fork and stacker	....
....	Walking plows..........	....	....	Manure spreader..........	....
....	Sulky plows..........	....	....	Corn shredder..........	....
....	Disk harrow..........	....	....	Ensilage cutter..........	....
....	Spike-tooth harrow..........	....	....	Corn sheller..........	....
....	Spring-tooth harrow..........	....	....	Potato planter..........	....
....	Roller..........	....	....	Potato sprayer..........	....
....	Weeder..........	....	....	Potato digger..........	....
....	Corn planter..........	....	....	Orchard sprayer..........	....
....	1-horse cultivator..........	....	....	Gasoline engines..........	....
....	2 or 3 horse cultivator..........	....	....	Dairy equipment..........	....
....	Corn binder..........	....	....	Poultry equipment..........	....
....	Grain binder..........	....	....	Evaporator..........	....
....	Grain drill..........	....	....	Harness..........	....
....	Hay loader..........	....	....	Minor equipment..........	....
....	....	....	....	....	....
	Total..........				....

Cash to run the business.—A certain amount of money is necessary for carrying on the farm business. This amount will vary widely on different farms, according to whether the farm receipts are distributed throughout the year or received at one time. It should represent the average amount of money that the farmer has on hand at all times during the year for the purpose of paying current expenses. In other words, it is the balance of his checking account. The amount of cash to run the business will range from $25 to $100 on most farms.

Total investment.—The total investment is made up of the sum of the five divisions enumerated in the preceding paragraphs—real estate, live stock, feed and supplies, machinery and tools, and cash to run the business. The ordinary form of diary does not have space for making a complete list of all the items included in the farm investment. These can be put in a separate book as previously suggested and only the totals copied into the diary.

FORM III.—*Statement for area, yields, and sales of crops.*

CROP RECORD.

Crops.		Yield.		Operator's sales.		
Kind.	Acres.	Per acre.	Total.	Amount.	Price.	Value.
Corn for grain						
Corn for silage						
Other corn						
Potatoes						
Spring wheat						
Winter wheat						
Rye						
Oats						
Barley						
Buckwheat						
Straw						
Hay						
Alfalfa						
Oat hay						
Oats and barley						
Oats and peas						
Field beans						
Cabbage						
Tobacco						
Cotton						
Hops						
Beets						
Seeds						
Apples, bearing						
Apples, not bearing						
Peaches						
Cherries						
Pears						
Strawberries						
Total						

FORM IV.—*Statement for live stock, animal products, and miscellaneous receipts.*

LIVE STOCK.

Animals—kind.	Sales.			Purchases.			Died.
	No.	Value.	Total.	No.	Value.	Total.	No.
Cows							
Heifers							
Calves							
Bulls							
Steers							
Oxen							
Horses							
Mules							
Colts							
Ewes							
Lambs							
Brood sows							
Other hogs							
Pigs							
Chickens							
Turkeys							
Ducks							
Bees							
Total							

RECEIPTS FROM STOCK PRODUCTS.

	Amount.	Price.	Value.
Butter			
Creamery milk			
Market milk			
Cheese			
Wool			
Eggs			
Hides			
Honey			
Breeding fees			
Total			

RECEIPTS, MISCELLANEOUS SOURCES.

	Amount.	Price.	Value.
Labor			
Machine work			
Cash rent for			
Rent of buildings			
Sirup and sugar			
Lumber, posts, etc			
Total			

FARM RECEIPTS AND EXPENDITURES.

Receipts can be divided into six groups, as shown in the diagram on page 8. The first two of these, namely, increase in live stock and in feed and supplies, can only be obtained at the end of the year by comparing the new inventory with that of the preceding year. Often there will be no increase in either of these items, but rather a decrease, which should be put under expenditures instead of receipts.

FORM V.—*Statement for current expenses.*

CURRENT EXPENSES.

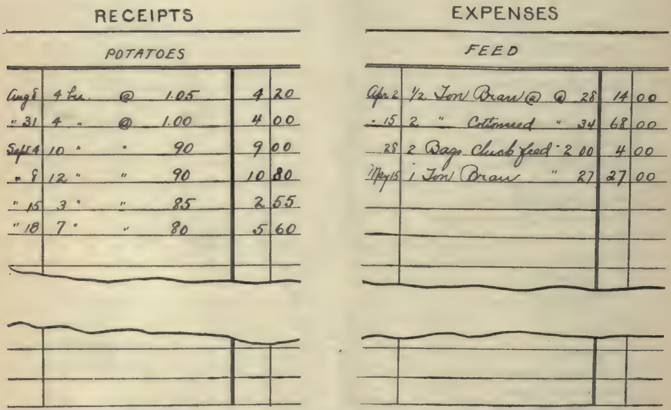
	Operator.
Regular hired labor . . . mo.	
Extra hired labor . . . mo.	
Board of hired labor . . . mo.	
Family labor . . . mo.	
Board of family labor	
Repair of machinery	
Repair of buildings	
Repair of fences	
Feed: Hay, silage, etc	
Feed: Grain and concentrates	
Feed grinding	
Silo filling	
Corn shredding	
Milk hauling	
Horseshoeing	
Breeding fees	
Veterinary	
Seed, plants, trees	
Fertilizer, manure	
Spray materials	
Twine	
Thrashing	
Baling	
Machine work hired	
Fuel and oil for farm work	
Bags, barrels, crates	
Cotton ginning	
Insurance	
Taxes on farm property	
Water tax	
Cash rent	
Total	

DEPRECIATION ON EQUIPMENT AND BUILDINGS.

Dwelling, .. per cent of value	
Other buildings, .. per cent of value	
Machinery, .. per cent of value	
Total	

Whether the receipts from crops and other sources are kept under their respective headings in the back of the diary or are entered each day at the bottom of the pages, as shown in figure 3, it will be a great help to make out a crop summary as given in Form III. This gives a statement of the area and yield of each crop, quantity sold, and amount received therefor. This kind of a statement is also desirable for the live stock, live-stock products, and miscellaneous receipts. (See Form IV.)

The farm expenses may be grouped into the divisions shown in the outline on page 8, or if desired, they may be subdivided in more detail, as is done in Form V, for current expenses.



RECEIPTS

POTATOES

Aug 8	4 bu.	@	1.05	4	20
" 31	4 "	@	1.00	4	00
Sept 4	10 "	"	90	9	00
" 8	12 "	"	90	10	80
" 15	3 "	"	85	2	55
" 18	7 "	"	80	5	60

EXPENSES

FEED

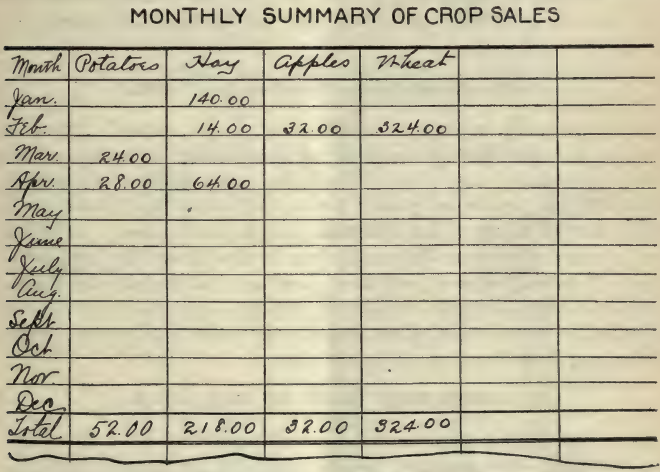
Apr 2	1/2 Ton Bran @ @	28	14	00
" 15	2 " Cottonseed "	34	68	00
" 28	2 Bags Chick feed "	2 00	4	00
May 15	1 Ton Bran "	27	27	00

FIG. 4.—Sample pages showing method of entering receipts and expenses directly to respective accounts. (Compare with method of making daily entries at bottom of each page as suggested in fig. 3, p. 6.)

There are two or three ways of keeping a record of receipts and expenses, depending upon the form of diary used. For example, a page or part of a page in the back of the book may be set aside for a record of each class of receipts and expenses. (See fig. 4.) This method necessitates turning to different places in the diary each time a financial transaction is entered. However, it has the great advantage of having in one place all the items pertaining to any crop or kind of expense. As a rule an entire account will go on a single page, where it can be easily added.

It should be carefully noted that personal items are not included in these expenses. It is the farm income that is wanted, not the amount of money saved after all living and personal items of expense have been deducted from the gross receipts. Many persons confuse the amount of money on hand at the end of the year with the net return from the farm business. It makes no difference how profitable the farm may be, the farmer will not be able to save much if the living expenses are out of proportion to the income. Often the man who operates the more successful farm fails to accumulate money as fast as the less successful farmer who saves all he gets. The farm and its possibilities are one thing and the standard of living of the farmer and his family are another. Although a farm may produce a handsome profit yearly, the owner of it may grow poorer from year to year if the family living expenses exceed the profits of the farm business.

When a form of diary is used where the memoranda of work and the financial transactions are all put on one page, as in figure 3, it is desirable to make a monthly summary of each class of receipts and expenses. An excellent way of doing this is illustrated in figure 5. This monthly summary should be in the back of the book and contain only the totals for each kind or class of receipts and expenditures. This method makes a little more work than does that in which the items are entered directly in the separate accounts, but this is largely offset by having all the original records for one day on one page.


MONTHLY SUMMARY OF CROP SALES

Month	Potatoes	Hay	Apples	Wheat		
Jan.		140.00				
Feb.		14.00	32.00	324.00		
Mar.	24.00					
Apr.	28.00	64.00				
May						
June						
July						
Aug.						
Sept.						
Oct.						
Nov.						
Dec.						
Total	52.00	218.00	32.00	324.00		

FIG. 5.—Statement of monthly summary receipts from crop sales. This statement is useful in connection with form of diary shown in fig. 3.

FARMER'S LABOR INCOME.

Having determined the total farm receipts and expenses, it is an easy matter to subtract one from the other and find the farm income. This sum represents the amount of money the farmer receives for his labor and his investment. This same capital, however, if otherwise invested, would earn him a reasonable rate of interest without much work on his part. Therefore to find what he receives for his labor alone it is necessary to subtract interest on his farm investment from the farm income. The remainder is called the farmer's "labor income." It very often happens that the farm, at present value, does not pay the current rate of interest on the total investment. This results in the labor income being a minus quantity. A farmer may have a minus labor income and yet live comfortably, the reason being that he has the interest on his investment to use for his living expenses. But when the farm income—that is, the difference between receipts and expenses—is a minus quantity, he will not have a good living, because it means that he has paid out more than he received without even allowing himself any pay for his labor or interest on his farm investment.

VALUE OF HOME SUPPLIES FURNISHED BY FARM.

Approximately two-thirds of the cost of the farmer's living is furnished by the farm without direct expenditure in money. This sum, representing the value of food, fuel, and shelter, amounts to about $90 per person per year.[1] On a small farm this constitutes a large part of the total farm income, and it should always be taken into account when considering the net income from the farm business. If desired, a record of these items may be kept by the housewife in connection with family or personal expenses. It is very doubtful, however, whether the farmer will want to go to the trouble of keeping these items in his farm diary.

ACCOUNTS WITH CROPS OR LIVE STOCK.

In the preceding discussion only those accounts have been considered which are necessary to determine the net income from the farm business as a whole. They will not tell whether any particular crop was grown at a profit or loss.

The accounts for any crop or class of live stock are called cost accounting records. They bear the same relation to the farm business as a manufacturer's accounts with wagons, sleighs, etc., do to his business. Very few farmers care to keep a full set of cost accounts on all phases of the farm business. However, records on some particular crop or class of live stock may be very desirable. The items which must be considered in an account with a crop are as follows:

CHARGES.

Inventory of amount of work, seed, etc., if any, previous to beginning the account.

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[1] See Farmers' Bulletin No. 410, "Value to Farm Families of Food, Fuel, and Use of House."

Part of manure charge from previous crops.
Value of manure applied for this crop.
Commercial fertilizers, all or part to this crop.
Seed.
All man labor, including supervision.
All horse labor.
Use of machinery.
Use of buildings for storage of crops.
Use of land.
Other miscellaneous costs.
Interest on costs until crop is sold or fed.

CREDITS TO CROP.

All products sold, used by the family, fed on the farm, saved for seed, or used for bedding.

Probable value of manure left in soil but charged to crop.

Inventory, or amount on hand at end of year.

The items to consider in a cost-accounting record of live stock are as follows:

CHARGES.

Inventory, or total value of stock, feed, etc., at beginning of year.
Live stock purchased.
Feed and bedding used.
Pasture.
All man labor, including supervision.
All horse labor.
Use of machinery.
Use of buildings.
Miscellaneous costs, insurance, etc.
Interest on investment.

CREDITS.

Sale of live stock and live-stock products.
Skim milk, etc., fed to other stock.
Products used by the family.
Value of manure.
Inventory at end of the year.

A diary is well adapted to keeping cost-accounting records when information is wanted on only a few enterprises. In writing up the diary each day it will take very little additional time to enter the hours and minutes spent in work on the crop under consideration. Along with the record of the work done notes should be made of the seed, fertilizer, etc., used (see fig. 3, p. 6).

If cost-accounting records are to be kept on all the farm enterprises, it will probably be desirable to have a page or so set aside for each crop and each class of live stock, and to enter all items pertaining to each enterprise direct. If the form shown in figure 3, page 6, is followed there is entailed the work of going through each day's record and picking out items pertaining to each enterprise. Many farmers, however, use a diary for this purpose, finding it very convenient for reference; then, if any time they want the total of the work spent on a crop, they have the necessary original records.

ACCOUNTS WITH FIRMS OR INDIVIDUALS.

Accounts with outside firms or persons are necessary when any portion of the business is done on credit. Such accounts contain a record of what you owe and to whom, and what is owed you and by whom. Such accounts sometimes save paying a bill twice and help to avoid mistakes and disputes. The simplest way of keeping such records is to enter the items directly to the account with each person or firm. A few pages in the back of the diary can be used for this purpose. If there are only a few such items, the form of diary shown in figure 3 is excellent for this kind of records.

MISCELLANEOUS ACCOUNTS.

Many farmers find certain miscellaneous records exceedingly interesting and valuable. Among the more important of these are milk and egg records. The diary is especially well suited for keeping the latter. For milk records of individual cows special forms are desirable. In keeping these there is a greater tendency on the part of many dairymen to weigh the milk of each cow a few days each month instead of weighing the milk each day of the month. The record for each month is then computed from these weighings, thereby saving much work. Such records are accurate enough for most practical purposes.

CONCLUSION.

Farm records should to some degree form a part of every farm business. The particular method of keeping them is not important so long as the accounts give the desired information. The great majority of farmers do not need elaborate accounts, as the size and limitations of their business will not justify the work. On the other hand, a memorandum of important transactions and of the daily farm happenings will prove to be extremely useful. At times it may save money and trouble. A large number of successful farmers have found a diary desirable in that it serves all their bookkeeping needs.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO FARM ECONOMICS.

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What the Farm Contributes Directly to the Farmer's Living. (Farmers' Bulletin 635).

Methods of Analyzing Farm Business. (Farmers' Bulletin 661).

Waste Land and Wasted Land on Farms. (Farmers' Bulletin 745).

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A Farm Management Survey of Three Representative Areas in Indiana, Illinois, and Iowa. (Department Bulletin 41).

Profits in Farming on Irrigated Area in Utah Lake Valley. (Department Bulletin 117).

Cooperative Organization Business Methods. (Department Bulletin 178).

Machinery Cost of Farm Operations in Western New York. (Department Bulletin 338).

Farm Management Practice of Chester County, Pa. (Department Bulletin 341).

A System of Accounts for Primary Grain Elevators. (Department Bulletin 362.)

A System of Accounts for Live-stock Shipping Associations. (Department Bulletin 403).

Labor Requirements of Dairy Farms, as Influenced by Milking Machines. (Department Bulletin 423).

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE.

Cost of Raising a Dairy Cow. (Department Bulletin 49). Price 5 cents.

Cost of Fencing Farms in the North Central States. (Department Bulletin 321). Price 10 cents.

Normal Day's Work for Farm Implements, Workmen, and Crews in Western New York. (Department Bulletin 412). Price 5 cents.

The Cost of Producing Minnesota Dairy Products, 1904–1909. (Statistical Bulletin 88.) Price 10 cents.

UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN

WASHINGTON, D. C. 783 OCTOBER 19, 1916

Contribution from the Bureau of Biological Survey, Henry W. Henshaw, Chief.

LAWS RELATING TO FUR-BEARING ANIMALS, 1916.

A SUMMARY OF LAWS IN THE UNITED STATES AND CANADA RELATING TO TRAPPING, PROTECTION, PROPAGATION, AND BOUNTIES.

By D. E. LANTZ, *Assistant Biologist.*

INTRODUCTION.

The value of the raw fur production of the United States and Canada has grown enormously in spite of the steadily diminishing supply of animals that furnish the finer pelts. In 1915 trappers of North America earned by their industry probably not less than $20,000,000, a remarkable sum when it is remembered that exports of raw furs were only about half the normal proportions. Conditions of the trapping industry have been greatly improved in recent years by legislation protecting fur animals in much of the territory where the business is important. As with game laws, each year brings changes in the trapping regulations, and it becomes important that the rights and privileges of trappers, as well as the limitations placed on their calling, be made plain. The present bulletin is designed for this purpose. It gives a brief review of changes made by legislative enactments of the past year, a summary of trapping regulations now in force, followed by short statements of the open seasons for taking furs, provisions relating to propagation of fur animals, and bounties offered for the destruction of predatory species, or those considered harmful. These are given by States and Provinces, arranged in alphabetic order. The whole is followed by a brief summary of the protection given the more important species.

The laws relating to deer and other big game, rabbits, and squirrels are not considered here, as they appear in the annual game-law bul-

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NOTE.—This bulletin is intended for general distribution among persons interested in fur farming, trapping, and the fur trade.

letin.[1] Those relating to bears are included, mainly because of their interest in connection with bounties.

Throughout the following pages references to legislation give date of law or code, followed by number of section, chapter, or act containing the provision. References are sometimes omitted when provisions from various enactments are grouped in a single sentence or short paragraph.

Under the heading "Trapping" the expression "no legal restrictions" indicates only that no specific trapping provisions exist, the general trespass laws of the State not having been considered.

Under the heading "Open seasons" the dates given are, unless otherwise stated, the first day of the open season and the first day of the following close season; to find the close season *reverse the dates.*

LEGISLATION OF 1916.

As only 11 States had legislative sessions in 1916, few changes in trapping regulations were made. Two States—Kentucky and Mississippi—for the first time enacted general laws protecting fur animals. In Kentucky a close season on beaver, mink, raccoon, fox, otter, and opossum is provided, January 1 to November 15, except that raccoon, opossum, skunk, and mink may also be taken and killed by dog or gun between October 1 and February 16. The act contains also restrictions on trapping on lands of another and on methods of setting traps.

The Mississippi law provides a close season on all fur animals except fox, opossum, and rabbit from February 1 to December 15 of each year. Foxes are protected during April, May, June, and July, and may be taken in other months by chase only. A resident license for trapping is provided and nonresidents are not permitted to trap in the State.

The Virginia Legislature of 1916 passed a general law regulating trapping of fur animals within the State and fixing the season for taking fur animals, but added the provision that the act shall not become effective in any county until the board of supervisors shall have adopted it.

In Rhode Island the season for trapping skunk, muskrat, raccoon, and mink has been lengthened by making the opening day November 1 instead of November 10.

In Alberta the open season for otter and muskrat has been lengthened to six months by the addition of April.

In British Columbia the season for trapping fox has been reduced by closing it 15 days earlier; the season for taking other fur animals has been extended one month, to May 1.

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[1] Farmers' Bulletin 774, Game Laws for 1916.

In Manitoba several changes in trapping regulations have been made. The close season for fox and lynx and the open season for otter and beaver south of the fifty-third parallel have been abolished, and the open season for fisher, marten, and mink has been shortened by a month.

In New Brunswick an open season on sable, November 1 to April 1, follows the close period, which expired July 1, 1916.

In Ontario a resident license is now required to trap except on one's own lands. The open season for muskrats south of French and Mattawa Rivers has been fixed as March 1 to April 21; north of these rivers April 1 to May 21.

The game act of Saskatchewan has been amended by making the open season for fox May 15 to February 15; for beaver the close season north of Churchill River is May 1 to November 1; south of Churchill River the close term has been extended to December 1, 1920.

The laws of Quebec have been amended so as to require all trappers and fur traders to send to the minister of colonization, mines, and fisheries before the 1st of September of each year, a report of the number of skins of each kind taken, bought, or sold during the preceding year.

On February 1, 1916, the Department of Commerce promulgated new trapping regulations for Alaska. The principal changes embrace a close season for marten extending from March 15, 1916, to November 15, 1921, and shortening the open season for lynx (wildcat) by 15 days.

FEDERAL LAWS.

Two Federal laws have a bearing on the fur industry of the United States—the Lacey Act, governing interstate commerce in game, and the tariff act of October 3, 1913.

That part of the Lacey Act codified as section 242 of the Criminal Code (35 Stat., 1137) makes it unlawful to ship or transport " from any State, Territory, or District of the United States, to any other State, Territory, or District thereof " the bodies or parts of bodies of any wild animal or bird killed or shipped in violation of law of the State, Territory, or District in which the same were killed or from which they were shipped. This makes it unlawful to ship out of any State skins or pelts illegally taken. Packages containing furs, when shipped in interstate commerce, must be plainly marked so that the name and address of the shipper and the nature of the contents may be readily ascertained by inspection of the outside of the package.

The tariff act of 1913 places a duty of 10 per cent ad valorem on live animals shipped into the United States. Paragraph 397 of this law places on the free list animals imported for breeding purposes by a citizen of the United States: "*Provided*, That no such animal shall be admitted free unless pure bred of a recognized breed and duly registered in a book of record recognized by the Secretary of Agriculture for that breed." This act has made it impossible thus far to admit free of duty any foxes or other Canadian fur animals for propagation. Raw furs not advanced in manufacture are admitted free of duty.

LAWS OF STATES AND PROVINCES.

ALABAMA.

Trapping.—Poisons, drugs, or chemicals may not be used in taking game or fur animals.

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—None paid.

ALASKA.

Trapping.—The Secretary of Commerce makes all regulations for taking fur animals in Alaska. Under regulations published February 1, 1916, it is unlawful to use a "klips" trap, a steel bear trap, or any trap having a spread exceeding 8 inches; to kill any fur-bearing animal with strychnine or other poison; to trap protected fur animals at any time when the skin or pelt is not prime; to have in possession or sell or export unprime skins (such skins subject to confiscation). Shipments of furs must be reported to the Bureau of Fisheries, Department of Commerce, on blanks provided for that purpose.

Open seasons.—Land otter and mink, November 16 to April 1; weasel, November 16 to March 15; muskrat, December 1 to June 1; lynx (wildcat), November 16 to March 1; fox, November 16 to March 1.[1] No close season for black bear, wolf, wolverine, ground squirrel, or rabbit. Close season on marten until November 15, 1921; on sea otter until November 1, 1920; on beaver until November 1, 1918. No open seasons in Aleutian Islands Reservation, and trapping may be done there only by special permit.[2]

Propagation.—Owners of establishments for breeding fur animals are subject to the same restrictions as to season for killing and condition of pelts as are trappers of wild fur-bearing animals. Fur farmers are required to furnish reports to the Bureau of Fisheries and to allow agents of that bureau free access to establishments where animals are kept in captivity.

Within the Aleutian Islands Reservation the Department of Agriculture grants permits to propagate fur animals and to trap them for breeding purposes. The Afognak Reservation was set aside in 1892 for the protection of salmon and sea otters.

Bounties.—Wolf, $10 (session 1915).

ARIZONA.

Trapping.—No legal restrictions.

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

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[1] *South of latitude 62°.*—Open season for brown bear, October 1 to July 2. *North of latitude 62°.*—Open season for walrus, May 10 to July 2; no close season for brown bear or sea lion. (35 Stat., 102.)

[2] The fur-seal fisheries, the Aleutian Islands Reservation, and the Afognak Reservation are subject to special legislative and administrative control. For specific information regarding them, application should be made to the Commissioner of Fisheries, Washington, D. C.

Bounties.—Wolf and mountain lion, $10 each; coyote, $2; lynx or wildcat, $1; raccoon, 25 cents; jack rabbit, gopher, and prairie-dog, 5 cents each; paid by county (1912, ch. 82).

ARKANSAS.

Trapping.—Nonresidents are not allowed to hunt or trap in the State.[1] Resident trappers using more than 10 traps are required to take out a trapper's license (fee, $10).

Open seasons.—Bear, November 21 to January 11. Beaver and otter protected absolutely until March 11, 1920 (1915, ch. 124). No close season on other fur animals.

Propagation.—No legal restrictions.

Bounties.—County courts may offer bounty on wolf, wildcat, or panther, and fix the amount of such bounty (1885, No. 44).

CALIFORNIA.

Trapping.—Except beavers and sea otters, fur-bearing animals are included under the term "predatory animals," as defined in a recent act (1915, ch. 64). A permit is required to trap fur or predatory animals on State game refuges.

Open seasons.—No open season on beaver or sea otter. Seals and sea lions are protected at all times in game district 19, which includes ocean waters adjacent to the Santa Barbara Islands, except Catalina (Penal Code, sec. 637c). No close season on other fur animals.

Propagation.—No legal restrictions.

Bounties.—Mountain lion, $20, paid by State game commission. Boards of supervisors of counties may at their discretion fix the rate and pay bounty on coyote, wildcat, fox, lynx, bear, or mountain lion. Many counties now pay a bounty on some of these animals, especially on coyotes.[2]

COLORADO.

Trapping.—Hunting license required for trapping; fee, resident, $1; nonresident, $10. Beavers may not be trapped for fur at any time, but the owner of property damaged by the animals may apply to the State game and fish commissioner for a permit to kill them under such regulations as he may provide as to the disposition of the skins (1909, revising secs. 2753, 2759b).

Open seasons.—No close season for fur animals, except beaver.

Propagation.—No legal restrictions, except as to beaver and game animals.

Bounties.—None paid by State since 1895. On petition of 50 freeholders, county commissioners may levy a tax to pay a bounty on coyote, wolf, and mountain lion.

CONNECTICUT.

Trapping.—Unlawful to trap with scented baits (1903, ch. 56); to trap on lands of another without owner's permission (1909, ch. 37); and to take animals with a snare (1913, ch. 79). Hunting license is required for trapping (except on land owned by trapper); fee, resident, $1; nonresident, $10; alien, $15; with an additional 25 cents recording fee for each license. Persons under 16 years of age, while denied a hunting license, may obtain one for taking fur animals only (1907, ch. 153; 1915, ch. 240).

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[1] Probably permitted to trap on their own lands, in accordance with a decision of the Supreme Court of Arkansas as to hunting. (State *v.* Mallory, 83 S. W., 955.)

[2] For information in regard to bounties in any county, application should be made to the county clerk.

Open seasons.—Otter, November 1 to April 1 (1905, ch. 5); raccoon, September 2 to March 1, but landowner may kill raccoons at any time to protect crops (1915, ch. 130). No close season for other fur animals.

Propagation.—No restrictions on possession or sale of fur animals raised in captivity.

Bounties.—State bounty on fox repealed (1915, ch. 114), and also town bounty on raccoon (1915, ch. 130). Towns are permitted to pay bounty on wildcat (not over $5), skunk, fox, weasel, wild Belgian hare, or wild German rabbit (not over $1 on each) (1915, ch. 46).

DELAWARE.

Trapping.—Nonresident trappers are required to hold hunting license (fee, $10.50). Unlawful to use pitfall, deadfall, scaffold, cage, snare, trap, net, pen, baited hook, or baited field or any other similar device, or any drug, poison, chemicals or explosives for taking birds or animals protected by the laws of this State, except muskrats, skunks, minks, and otters, and except as otherwise expressly provided. Traps or other devices unlawfully set are subject to confiscation (Rev. Stat. 1914, sec. 2378). Muskrats may not be taken during the time of any flood or freshet when such flood or freshet may cause them to leave their usual places of shelter and protection (sec. 2387). Muskrats may not be shot at night (sec. 2380) or hunted with a dog (sec. 2388). Unlawful to destroy the nest, den, or lair of any animal protected by law (sec. 2378). Unlawful to hunt, kill, take, or destroy any protected animal, except muskrat, skunk, mink, and otter, while the ground is covered with snow (sec. 2382). Unlawful to shoot at or destroy any fox while such fox is being chased by dog or dogs (sec. 2385). Unlawful to sell or export any fox or fox hide (sec. 2408). Owners of property may at any time destroy fur-bearing animals to protect such property (sec. 2375).

Open seasons.—Skunk, mink, and otter, December 1 to March 11; muskrat, Kent and Sussex Counties, November 20 to March 16 (Newcastle County, December 1 to March 11); fox, October 1 to May 1; raccoon, October 1 to February 16; opossum, October 1 to February 16 (1915, ch. 194).

Propagation.—No restrictions, provided a permit is obtained from the chief game and fish warden (fee, $1). A restricted number of wild fur or game animals for propagating purposes may be taken under permit.

Bounties.—None paid.

DISTRICT OF COLUMBIA.

No legislation relating to fur animals.

FLORIDA.

Trapping.—No legal restrictions.

Open seasons.—Beaver and otter, November 1 to February 1 (1905, No. 57). No close season for other fur animals.

Propagation.—No legal restrictions.

Bounties.—None paid.

GEORGIA.

Trapping.—Permission of owner required to trap on lands of another. Hunting license required to trap outside one's own militia district; fees for State license, nonresident, $15; resident, $3; county license, $1.

Open seasons.—Opossum, October 1 to March 1 (C. Code 1911, sec. 590); fox, Habersham County, September 1 to May 15 (1914, No. 304). Fur animals not otherwise protected.

Propagation.—No legal restrictions.

Bounties.—None paid.

HAWAII.

Hawaii has no wild animals valuable for fur. There are no restrictions on the propagation of fur animals, except that mongooses and rabbits may not be kept or bred. Pet rabbits may be raised, if kept in confinement (1905, ch. 37).

IDAHO.

Trapping.—No restrictions, except in State game preserves.

Open seasons.—No open season for beavers, but owner of property destroyed by these animals may obtain a permit to kill them from the State fish and game warden. Skins of animals so killed must be sent to the warden, who shall sell them and apply the proceeds to the State game fund (1911, ch. 62). No close season on other fur animals, except in State game preserves.

In Black Lake Game Preserve, beaver, otter, marten, fisher, fox, mink, and wolverine are protected at all times; mountain lion, bear, lynx, wolf, coyote, and wildcat may be destroyed by game warden or duly authorized person (1915, ch. 9).

In Payette Game Preserve, bear, lynx, wolverine, fox, otter, beaver, marten, mink, and fisher are protected at all times; mountain lion, timber wolf, coyote, and wildcat may be killed by game wardens or duly authorized persons (1909, H. B. 242).

Propagation.—No restrictions, except in game preserves.

Bounties.—Coyote, lynx, or wildcat, $2.50 each; bear or wolf, $10; mountain lion, $25; paid from predatory wild animal fund administered through the State live stock sanitary board (1915, ch. 73).

ILLINOIS.

Trapping.—No legal restrictions.

Open seasons.—Raccoon, mink, muskrat, skunk, opossum, and otter, November 1 to April 1 (1915, S. B. 439, sec. 4).

Propagation.—Permit is required to conduct a fur farm on which protected animals are reared; fee, $2, and bond of $500 required (1915, S. B. 409).

Bounties.—None paid by State. Counties may at their discretion pay bounty on ground hog and crow (1909, H. B.'s 686, 687).

INDIANA.

Trapping.—Protected fur animals may be killed at any time when destroying property. Muskrat houses may not be destroyed (1911, ch. 6).

Open seasons.—Mink, raccoon, opossum, skunk, and muskrat, November 1 to April 1 (1911, ch. 6).

Propagation.—All birds and animals raised in captivity are considered domestic stock, and the owner may possess, sell, ship, transport, or otherwise dispose of them without regard to laws regulating the killing and disposition of wild birds and animals (1915, H. B. 37).

Bounties.—Crow, 10 cents each; paid by counties (1911, ch. 133). Boards of county commissioners are authorized at their discretion to pay bounty on wolf, woodchuck, owl, or hawk (Ind. Stat., Burns, sec. 7871).

IOWA.

Trapping.—Hunting license required for trapping; fee, resident $1, nonresident $10.50 (1915, S. F. 621).

Open seasons.—Beaver, mink, otter, and muskrat, December 1 to April 1 (36 G. A., sec. 2553); other fur bearers not protected.

Propagation.—No legal restrictions.

Bounties.—Adult wolf, $20; wolf cub, $4; wildcat, $1; paid by county (1913, ch. 189). Boards of supervisors of counties may allow bounty on crow, ground hog, pocket gopher, or rattlesnake.

KANSAS.

Trapping.—The owner or legal occupant of land may destroy fur-bearing animals protected by law when such animals are destroying poultry or damaging other property (1911, ch. 198).

Open seasons.—Muskrat, skunk, mink, raccoon, opossum, and civet cat, November 15 to March 16. No open season for beaver or otter until 1921 (1911, ch. 198).

Propagation.—Permits for raising fur animals protected by law are issued by State game warden.

Bounties.—Coyote, $1; wolf, $5; crow and pocket gopher, 5 cents each; paid by county.

KENTUCKY.

Trapping.—Written consent of owner or lessee required to trap on lands of another. Traps must be set 18 inches or more within a hole, cave, or hollow log, and must be visited within each 36 hours. Traps set unlawfully may be seized or destroyed by any one. Fur animals may be killed at any time on one's own premises to protect property (1916, ch. 87).

Open seasons.—Beaver, mink, raccoon, otter, opossum, and skunk, November 15 to January 1; but raccoon, opossum, skunk, and mink may also be taken and killed by dog or gun, October 1 to February 16.

Propagation.—No legal restrictions.

Bounties.—None paid.

LOUISIANA.

Trapping.—License for trapping is required; fee, resident, $2; nonresident, $15 (1914, ch. 293). Muskrats may be taken at any time within 6 miles of any levee, and may be killed by the owner of land upon which they are destroying property. Skins of animals killed in open season may be possessed in close season. Wild ducks may not be used for trap bait (1912, ch. 204).

Open seasons.—Bear, November 1 to February 1 (may not be trapped); beaver, muskrat, mink, otter, raccoon, skunk, fox, and opossum, November 1 to February 16 (1912, ch. 204).

Propagation.—No restrictions, except as to capture during close season.

Bounties.—None paid.

MAINE.

Trapping.—Trappers in unorganized townships of the State are required to take out an annual license (fee, $5), and on or before December 15 of each year must make such report as the commissioners of inland fisheries and game may require (1911, ch. 64). Any person who sets a trap in an organized county or incorporated place must obtain written consent of the owner or occupant of land on which the trap is set, and must visit such trap at least once in every 24 hours and remove animals caught (1915, ch. 277). All traps must be plainly marked with owner's name and address, either by having the same stamped on the trap or on a metal tag firmly attached to it (1915, ch. 277). A set bear trap must have a notice that it is set posted conspicuously near it (1915, ch. 277).

Dealers in skins of fur animals must each year take out a license (fee, $2) to engage in this trade and must keep a record of transactions and forward same to the commissioners of inland fisheries and game on or before December 20 (1915, ch. 277). Putting out poison for wolves, foxes, dogs, or other animals is forbidden under penalty of fine or imprisonment (1909, ch. 134).

Traps may not be set within 25 feet of a muskrat house. A special law protects muskrats on Lower Kezar Pond and certain adjacent territory for four years from July 3, 1915 (1915, ch. 19). On complaint by landowners of damage done by beavers, the commissioners of inland fisheries and game have authority to declare an open season for beavers on lands where damage occurs (1915, ch. 222). Any person may lawfully kill any wild animal, except beaver, found destroying his property (1915, ch. 334).

Open seasons.—All fur animals (except beaver, muskrat, bear, bobcat, Canada lynx (loup cervier), and weasel), November 1 to March 1; muskrat, November 1 to May 1. No open season on beaver except when declared by the commissioners of inland fisheries and game. No close season on bear, bobcat, Canada lynx (loup cervier), or weasel (1913, ch. 206).

Propagation.—No legal restrictions, except that protected fur animals may not be captured in close season for stocking fur ranches, and that no animals may be imported into the State without permit.

Bounties.—Bobcat and Canada lynx (loup cervier), $4 each; paid by State. Claim for bounty must be made within five days after killing or return from trip on which killing was done (1913, ch. 206). The bounty on bears in certain counties was recently repealed (1913, ch. 36).

MARYLAND.

While the State has recently adopted a uniform open season for game, the counties still regulate the taking of fur animals. The State law protecting otter, raccoon, and muskrat from April 1 to January 1 (1900, ch. 371), was amended until it applied to only 6 counties (1912, ch. 843), and some of these have local laws which take precedence. Local laws providing protection to fur animals or regulating their capture are in force in the following counties:

Allegany County.—Raccoon and opossum, open season, September 1 to April 1; hunting license required to capture either (1916, ch. 282). Bounty on wildcat, $2; fox, $1; hawk or hoot owl, 50 cents (1910, ch. 616).

Anne Arundel County.—Raccoon, open season, October 1 to February 1; may not be taken between sunrise and sunset; unlawful to cut down tree to obtain a raccoon (1916, ch. 367); muskrat, open season, December 2 to March 1. Unlawful at any time to destroy muskrat dens or houses, unless the animals are destroying property (1906, ch. 589).

Baltimore County.—Unlawful to set traps, except from November 10 to December 21. Unlawful to pursue or kill raccoons and opossums, except from October 1 to February 28 (inclusive); unlawful to hunt them on Sundays or when snow covers the ground. Permits to take certain predatory fur animals when destroying property may be obtained, but such permits may be revoked at any time by the chief game warden (1912, ch. 751).

Caroline County.—Muskrat, open season, December 15 to April 1; raccoon, September 15 to March 31; otter, December 15 to April 1 (1902, ch. 157). Unlawful for nonresidents to trap without license (fee, $4.50). Unlawful to dig into or destroy muskrat homes or dens, except when animals are destroying property (1902, ch. 157). Unlawful to use reflector or artificial light in taking muskrats or otters (1904, ch. 91). Unlawful to kill a fox except by hounds in a hunt or when the fox is destroying poultry (1916, ch. 450).

Carroll County.—Unlawful to kill fox except by hounds in a hunt or when the fox is destroying poultry (1916, ch. 450).

Cecil County.—Muskrat, open season, December 1 to March 1; may be taken only by trapping (1914, ch. 39). Trapping on lands of another without written permission is unlawful (1914, ch. 464).

Charles County.—Unlawful to shoot muskrats on Nanjemoy Creek and tributaries by aid of light (1912, ch. 362).

Dorchester County.—Raccoon and otter, open season, January 1 to April 1 (State law); muskrat, January 1 to March 16 (local law). Unlawful to shoot muskrats (1900, ch. 205) or to use artificial light in taking them. Bounty on crow, 5 cents.

Frederick County.—All fur animals, open season, November 15 to March 1, but night hunting with dogs for raccoon or opossum is lawful at any time (1916, ch. 128). Bounty on wildcat, $2; mink or fox, $1; weasel, owl, or hawk, 50 cents.

Garrett County.—Bounty on panther or wolf, $20; wildcat, $3; fox, $1; weasel, 50 cents (1916, ch. 13).

Harford County.—Except for muskrats, trapping is forbidden from December 25 to November 15 of the following year. Open season for raccoon, October 2 to December 1. License required to take muskrats or skunks; fee, resident, $1.15; nonresident, $5.15. Unlawful to trap on private property without permission of owner. Bounty of 50 cents each on chicken hawk, pigeon hawk, booby owl, or weasel (1916, ch. 307).

Kent County.—Otter, raccoon, and muskrat, open season, January 1 to April 1 (State law). Unlawful to use light in hunting muskrats.

Montgomery County.—Raccoon and opossum, open season, October 15 to January 15; muskrat, November 15 to March 1. Nonresident requires license to hunt raccoon or opossum (fee, $15.50). Setting a snare or trap in or about a fox den is unlawful. Bounty on hawks, 40 cents (1912, ch. 438).

Prince Georges County.—Unlawful to hunt, shoot, or trap muskrats in Aquasco district, between March 15 and January 1, or to spear them at any time (1910, ch. 688). Raccoon, open season, October 1 to February 1; may not be taken between sunrise and sunset; unlawful to cut down tree to capture raccoon (1916, ch. 376).

Queen Annes County.—Otter, raccoon, and muskrat, open season, January 1 to April 1 (State law).

Somerset County.—Otter and raccoon, open season, January 1 to April 1 (State law); muskrat, January 1 to March 16 (local law). Unlawful at any time to shoot muskrats.

Talbot County.—Otter and muskrat, open season, December 16 to March 16. Dealers may have skins of either in possession up to March 31. Unlawful to take otter or muskrat at night, except in traps (1912, ch. 785).

Washington County.—Muskrat, mink, skunk, opossum, and otter, open season, December 1 to April 1 (1916, ch. 320). Unlawful to shoot foxes while they are being chased by dogs.

Wicomico County.—Otter, mink, and muskrat, open season, December 15 to March 1. Unlawful to use light in hunting muskrats (1894, ch. 51).

Worcester County.—Muskrat, otter, and mink, open season, December 15 to March 1. Unlawful to trap on lands or marshes of another without permission (1910, ch. 239). Unlawful to chase fox with dogs, March 10 to September 1, or to shoot any fox while it is pursued by dogs (1904, ch. 652).

MASSACHUSETTS.

Trapping.—Poison may not be used to kill animals, except rats, woodchucks, or other pests on one's own premises. The use of steel traps with spread of over 6 inches, and "choke" traps with greater opening than 6 inches is unlawful, as is also the use of wire snares or of scented baits. Traps may not be set on lands of another without written consent. Traps must be visited at least once in 24 hours. Introduction of foxes or raccoons into Dukes County is prohibited (Rev. Laws 1902–1908, ch. 92).

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—Wildcat or lynx, $5; paid by town, but refunded by county (1903, ch. 344).

MICHIGAN.

Trapping.—License required for trapping; fee, resident, $1; nonresident, $10 (1913, No. 108). A special license (fee, $10) is required for trapping beavers. Such license permits the taking of 15 beavers, not more than 4 from a single colony. Unlawful to destroy beaver houses or dams or to have carcass or skin in possession without license seal attached (1911, No. 206). Unlawful to destroy muskrat house or to set trap within 6 feet of such house or to use firearms or explosives in taking muskrats. Unlawful to possess carcass or skin of any fur animal killed in close season. Fur animals, except beavers, may be destroyed on one's own premises to protect property (1909, No. 183). Unlawful to trap in State game refuges (1913, No. 360).

Open seasons.—Beaver, (under license), November 1 to May 15; otter, fisher, marten, fox, mink, raccoon, and skunk, November 1 to April 1; muskrat, November 1 to April 15. No close season on wolf, lynx, and wildcat (1909, No. 183).

Propagation.—Protected fur animals may not be taken in close season for breeding purposes without permit. Permit is also required to keep them in captivity during close season and to sell and transport them without the State.

Bounties.—Grown wolf, $25; wolf whelp under the age of 6 months, $10; wildcat, $3; lynx, $5; paid by county and one-half refunded by State (1909, No. 304).

MINNESOTA.

Trapping.—Unlawful to molest or destroy muskrat, mink, or beaver house or den at any time or to hunt these animals with dog, or dogs, provided, that in the open season for muskrats their houses may be opened to set traps, but not in such manner as to injure them as habitations for muskrats. If any of these animals are damaging property the owner may obtain a permit to kill them and destroy their houses or dams. Nonresidents must obtain license to trap mink, beaver, muskrat, or otter; fee, $10. Skins or pelts legally taken may be possessed, bought, or sold at any time (1913, ch. 32, sec. 4796).

Open seasons.—Mink and muskrat, December 1 to April 15. Permanent close season on beaver (1913, ch. 32, sec. 4796).

Propagation.—Permits to breed or domesticate mink, muskrat, skunk, and raccoon are issued by the State game and fish commission; fee, 1 cent for each animal in possession. Also bond ($500) is required, as guarantee that no wild animals will be captured during close season for other than breeding purposes. Persons having in lawful possession such fur-bearing animals have a property right therein and it is unlawful for others to enter inclosures where the animals are confined, or molest them, under such penalties as would result were they ordinary domestic live stock (1913, ch. 32, sec. 4797).

Bounties.—Grown wolf or coyote, $7.50; cub, $3; paid by county, refunded by State (1907, ch. 381). County or town boards may by resolution offer bounty on gopher, ground squirrel, ground hog, rattlesnake, crow, or blackbird (1909, ch. 48; 1911, ch. 220).

MISSISSIPPI.

Trapping.—Nonresidents are not permitted to trap in the State. Resident trapper requires additional State license (fee, $2.50). Permission is required to trap on lands of another (1916, S. B. 252).

Open seasons.—Bear, November 1 to March 1 (Code, sec. 2324); all fur animals (except bear, fox, opossum, and rabbit), December 15 to February 1; fox, unlawful to trap, shoot, or dig from dens (may be taken by chase only, and may not be chased during April, May, June, and July). Opossum and rabbit are not protected (1916, S. B. 252).

Propagation.—No legal restrictions.

Bounties.—None paid.

MISSOURI.

Trapping.—Wild fur-bearing animals may be destroyed at any time and in any way to protect premises from their depredations (Rev. Stat. 1909, sec. 6521a). Unlawful to offer pelts of protected animals for sale if taken out of season (1913, p. 348). Written permission required to trap on lands of another

(1913, p. 224). Use of poison prohibited in taking any protected animal (1915, H. B. 605).

Open seasons.—All fur animals, November 1 to February 1 (sec. 6521a).

Propagation.—Permits to capture for propagating purposes may be obtained from the State game and fish commissioner.

Bounties.—Adult wolf or coyote, $6; young wolf or young coyote, $3; paid by county and one-half refunded by State (sec. 10586).

MONTANA.

Trapping.—No legal restrictions, except as to trapping on State game preserves, where license (fee, $5) is required.

Open seasons.—No close seasons for fur animals, except beaver. Unlawful to take beavers at any time, except by owner of property for its protection. Unlawful to sell beaver skins or offer them for sale (Code, secs. 8783, 8785).

Propagation.—No legal restrictions.

Bounties.—Grown wolf, $15; wolf pup, $3; coyote or coyote pup, $3; mountain lion, $10; paid from State bounty fund raised by tax on live stock (1911, ch. 50).

NEBRASKA.

Trapping.—Unlawful to trap on premises of another without consent of owner (Code, sec. 2668).

Open seasons.—Muskrat, mink, or otter (on premises of another), February 15 to April 15. Beaver, no open season, but if the animals are damaging property a permit to destroy them may be obtained from the State game and fish commission (Code, sec. 2668). No close season for other fur animals; any except beavers may be taken at any time on one's own premises.

Propagation.—No legal restrictions.

Bounties.—Such counties as have at any general election voted to pay bounties, pay for wolf, $3; wildcat or coyote, $1; mountain lion, $3 (R. S., 1913, secs. 478–484).

NEVADA.

Trapping.—No legal restrictions.

Open seasons.—No close season except on beavers, which may not be taken until April 1, 1920 (1915, ch. 256).

Propagation.—License (fee, $10, paid annually to county) required from those who wish to propagate game or fur animals (except beaver). Animals on breeder's own lands may be taken at any time for propagation, and those held in captivity by holder of license may be sold at any time. No bounty may be collected on noxious species raised in captivity (1915, ch. 256).

Bounties.—Mountain lion, $5; lynx or wildcat, $2; coyote, 50 cents; paid by county. Not less than 5 scalps may be presented at one time by claimant (1913, ch. 23). Counties pay bounty of 1½ cents each for pocket gophers when at least 100 heads are presented at one time (1893, ch. 20).

The State board of live stock commissioners is authorized to pay bounty from funds derived from tax on horses, cattle, and hogs. The rewards are, for coyote, coyote pup, wildcat, or lynx, 75 cents each; mountain lion, $5 (1915, ch. 268).

The State board of sheep commissioners is authorized to pay bounty from funds derived from tax on sheep, the payments being the same as those made by the board of live stock commissioners (1915, ch. 247).

NEW HAMPSHIRE.

Trapping.—Fur-bearing animals defined as beaver, otter, marten, sable, mink, raccoon, fisher, fox, skunk, and muskrat. The right of anyone to kill predatory fur animals at any time when destroying domestic animals or fowls is granted. Skins legally taken may be bought or sold at any time. No person may destroy a muskrat house or set a trap therein, thereon, or at the entrance thereof. No person may trap upon lands of which he is not owner or lessee. All traps must be legibly marked or stamped with trapper's name, and must be visited at least once in 24 hours. It is an offense punishable by a fine to take traps of another or remove fur animals from them. The use of spring guns is unlawful. Bear traps must be safeguarded in a substantial manner. License for trapping, except on private lands, is required; fee, resident, $1; nonresident, $15 (1915, ch. 133).

Open seasons.—All fur-bearing animals, except beaver, November 1 to March 1. No open season for beaver. Raccoons and foxes may be taken by use of dog and gun during October (1915, ch. 133).

Propagation.—No restrictions other than those imposed by the trapping regulations.

Bounties.—Bear, $5 (1895, ch. 121); hedgehog, 20 cents (1911, ch. 93); wild cat, $2 (1915, ch. 133); paid by State.

NEW JERSEY.

Trapping.—Skunks, minks, muskrats, and otters may not be taken in close season, except that muskrats may be destroyed by owner of canal or dam which they are destroying. Muskrats may be taken by trap only, except in Salem County, above Mill Creek, where they may be taken in open season by firearms and light. It is unlawful to disturb the lodge or nesting chamber of muskrats, to molest traps set by another, or to appropriate or take animals caught in such traps (1913, ch. 126, 161).

Open seasons.—Skunk, mink, muskrat, and otter, November 15 to April 2 (1913, ch. 126); raccoon, October 1 to December 16 (1915, ch. 216). Beaver, unlawful to trap, take, kill, or have in possession at any time (1903, ch. 264). The board of fish and game commissioners may grant permits to hunt foxes with hound and firearms from the last day of the open season for game (Dec. 15) to March 31 (1913, ch. 157).

Propagation.—No restrictions except those imposed by close seasons, during which wild animals may not be taken for breeding purposes.

Bounties.—Fox, $3; paid by only a few counties (1902, ch. 112, amended by 1906, ch. 320).

NEW MEXICO.

Trapping.—No legal restrictions.

Open seasons.—No close season on fur animals, except beavers, which are protected at all times.

Propagation.—No restriction other than that respecting the capture of beavers.

Bounties.—Coyote, wildcat, or lynx, $2; wolf, $15; panther or mountain lion, $10; paid from county wild-animal fund, raised by tax on live stock (1909, ch. 104).

NEW YORK.

Trapping.—License required for hunting or trapping; fee, resident, $1.10; nonresident, $20.50; nonresident taxpayer, $10.50. Muskrat houses may not be molested, injured, or disturbed, nor the animals shot at any time. Skunks may not be taken by digging or driving them from dens by chemicals; if injuring property, they may be taken at any time and in any manner (1914, ch. 92).

Open seasons.—Mink, sable, and raccoon, November 10 to March 16 (1916, ch. 521); skunk, November 10 to February 11; muskrat, November 10 to April 21. No open season for beaver (1914, ch. 92).

Propagation.—All protected fur animals may be kept alive in captivity for propagation and sale, provided a license be obtained from the conservation commission (fee, $5). No fur-bearing animals may be kept which are taken wild during close season for such animals, nor may they be disposed of during close season (1914, ch. 92).

Bounties.—Panther, $20, paid by State; none paid since May, 1884.

NORTH CAROLINA.

Trapping.—Otters, muskrats, or minks may not be trapped nor their skins sold by anyone who has not resided in the State at least two years (1905, ch. 394).

Open seasons.—Open seasons for hunting and trapping are fixed by local laws; more than half of the 100 counties have local laws relating to fur animals.

Propagation.—No legal restrictions.

Bounties.—None now paid by the State.

Local trapping regulations.—The following local regulations are in force (October, 1916):[1]

Alamance County.—Opossum, open season, October 1 to February 1 (sec. 1883); fox, same open season. Unlawful to carry fox out of State in close season (1911, ch. 654). A misdemeanor to take foxes save only with dogs or dog (1909, ch. 616).

Anson County.—Fox, open season, August 1 to April 1 (1911, ch. 621).

Ashe County.—All fur animals, open season, November 1 to February 1 (1913, ch. 560).

Bertie County.—Opossum and raccoon, open season, October 1 to February 1. Trapping game with steel or log trap forbidden (1915, ch. 555).

Bladen County.—Opossum and raccoon, open season, October 31 to January 31 (1911, ch. 123). Setting traps in Colly Township regulated (1909, ch. 436).

Buncombe County.—Unlawful to trap on lands of another (1913, ch. 560).

Burke County.—Fox, close season in that part of the county lying south of Catawba River and Cleveland, March 1 to December 1, except when the animals are committing depredations (1907, ch. 388).

Caswell County.—Opossum, open season, October 1 to February 1 (sec. 1883).

Chatham County.—Opossum, open season, October 1 to February 1 (1911, ch. 756); fox, open season, September 1 to February 1 (1911, ch. 135).

Cherokee County.—Unlawful to hunt (except for foxes and wolves) on lands of another without written permission of owner or agent (1907, ch. 452).

Clay County.—Otter, open season, November 1 to April 1 (sec. 1883); fox, raccoon, and opossum, October 15 to January 15 (1911, ch. 200).

Columbus County.—All fur animals, open season, January 1 to April 1 (except in Bug Hill and Lee Townships, December 1 to March 1). Steel traps of a spread of 14 inches or more may be used at any time provided notice of their setting is posted (1909, ch. 417).

Craven County.—Otter, mink, muskrat, raccoon, and skunk, open season, December 1 to April 1. Owner of property may kill at any time to protect such property (1915, ch. 37).

Cumberland County.—A bounty of $5 is paid for each bear killed in Cedar Creek and Beaver Dam Townships (1905, ch. 176).

Currituck County.—Otter, raccoon, opossum, mink, and muskrat, open season, November 1 to April 1 (1913, ch. 560). Unlawful to shoot otter or muskrat in open season after sunset or before sunrise on east side of Currituck Sound (1909, ch. 537).

Duplin County.—Fox, open season, September 15 to February 15 (1911, ch. 407).

Durham County.—Opossum, open season, October 1 to February 1 (sec. 1883).

Edgecombe County.—Opossum, open season, October 1 to January 1 (1911, ch. 189).

Forsyth County.—Opossum, open season, October 1 to February 1 (1913, ch. 560).

Franklin County.—Opossum, open season, October 1 to February 1 (sec. 1883); fox, October 15 to March 1 (1913, ex. sess., No. 169).

Gates County.—All fur animals, open season, November 15 to April 1 (1911, ch. 745).

Graham County.—Opossum, open season, October 1 to February 1 (sec. 1883).

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[1] The references are to public local laws of various years or to sections of Pell's Revisal of 1908, ch. 40.

Greene County.—Opossum, open season, October 1 to February 1 (1907, ch. 598).

Guilford County.—Opossum, open season, October 1 to February 1 (sec. 1883).

Halifax County.—Raccoon and opossum, open season, November 15 to March 1; fox, September 15 to March 1. Unlawful to trap on lands of another without permission (1913, ch. 591).

Harnett County.—Opossum, open season, October 1 to January 1 (sec. 1883).

Haywood County.—All fur animals (except bear), open season, November 15 to January 15. No close season on bear, and fur animals may be destroyed at any time when preying on poultry, pigs, or lambs (1913, ch. 366).

Henderson County.—Fur animals, except wildcat, opossum, and mole, are protected by a close season from March 15 to November 15 (1913, ch. 560). The board of county commissioners are authorized to add to the list of protected fur bearers, and fix the open season for killing them (1915, ch. 677). Trapping on lands of another without permission of owner or agent is unlawful (1915, ch. 135).

Hoke County.—Unlawful to hunt or trap on lands of another without permission. Nonresidents require license (fee, $15, unless for hunting or trapping deer, wild turkeys, or foxes, when the fee is $25) (1915, ch. 459).

Johnston County.—Opossum, open season, in Bentonville, Boone Hill, and Wilder Townships, November 1 to March 1 (1913, ch. 648).

Lee County.—Fox, open season, October 1 to March 1; unlawful to carry out of State in close season (1911, ch. 291).

Lincoln County.—Opossum, open season, October 1 to January 1 (sec. 1883); fox, November 15 to February 1, except that when doing damage to fowls or other live stock, foxes may be killed at any time (1913, ch. 359).

McDowell County.—Opossum and raccoon, open season, October 15 to March 1 (1913, ch. 70).

Mecklenburg County.—Opossum, open season, October 1 to February 1; fox, November 15 to February 1. Foxes may be killed at any time if destroying property of value (1911, ch. 543).

Mitchell County.—Opossum and ground hog, open season, October 1 to February 15 (sec. 1883); raccoon, October 15 to February 1 (1913, ch. 369). Bounty of 50 cents each on weasel, mink, and horned owl (1913, ex. sess., No. 99).

Montgomery County.—Opossum, open season, October 1 to January 1 (1911, ch. 102); fox, October 15 to January 15 (1911, ch. 291).

Moore County.—Opossum, open season, October 1 to February 1 (sec. 1883); fox, October 1 to March 1 (1911, ch. 291); unlawful to carry fox out of State in close season.

Orange County.—Opossum, open season, October 1 to February 1 (sec. 1883).

Pamlico County.—Opossum, open season, October 1 to February 1 (sec. 1883).

Pasquotank County.—Raccoon, opossum, mink, muskrat, wildcat, and bear, open season, November 1 to April 1 (1913, ch. 369).

Pender County.—Fox, open season, September 15 to February 15 (1911, ch. 407).

Polk County.—Opossum, open season, October 1 to February 1 (1915, ch. 454).

Randolph County.—Opossum, open season, October 1 to January 1 (1911, ch. 24).

Richmond County.—Raccoon, open season, September 1 to April 1 (sec. 1883a); fox, October 1 to March 1 (may be taken only with dogs) (1913, ch. 520).

Robeson County.—All fur animals (including squirrel), open season, October 15 to March 1; unlawful to take them at any time by net, snare, or trap, except on one's own premises (1915, ch. 410).

Rockingham County.—Opossum, open season, October 1 to February 1; may be destroyed at any time by landlord or renter to protect crops (1911, ch. 756). Unlawful to shoot or trap fox (1905, ch. 752).

Rutherford County.—Fox, open season (in three townships—Golden Valley, Logans Store, and Duncans Creek), November 1 to February 1; to be hunted with dogs only (1913, ch. 591). No close season in other townships.

Sampson County.—Opossum, open season, October 1 to March 1 (1911, ch. 19).

Scotland County.—Unlawful to trap or hunt on private lands without permission of owner.

Stokes County.—Fox law of 1913 repealed (1915, ch. 551).

Surry County.—Opossum, open season, October 1 to January 1 (1915, ch. 289).

Swain County.—Mink, otter, muskrat, skunk, raccoon, and opossum, open season, November 15 to February 15; owner of property may kill at any time to protect it (1915, ch. 772).

Vance County.—Fox, raccoon, opossum, open season, November 15 to March 1; but may be run down and caught by dogs at any time (1913, ch. 718).

Wake County.—Raccoon and opossum, open season, October 1 to February 1 (1913, ch. 225).

Warren County.—Fox, no close season (1913, ch. 560).

Watauga County.—All fur animals (except mink and muskrat), open season, November 1 to March 15. They may be taken in open season only with dogs and gun or either. Mink and muskrat not protected (1913, ch. 533).

Wayne County.—Fox, open season, September 1 to March 1 (1909, ch. 912).

Wilkes County.—Opossum, open season, October 15 to March 1 (at night); but may be shot at any time when killing fowls or pigs. Fox, open season, October 1 to February 15, except that they may be killed in close season when destroying fowls; may not be shot at any time except to protect property (1913, ch. 77).

Yadkin County.—Opossum, open season, October 1 to March 1 (1911, ch. 71).

NORTH DAKOTA.

Trapping.—A license is required to trap except on one's own lands; fee, resident, $1; nonresident, $25. The protected fur animals are mink, muskrat, otter, and beaver; but minks and muskrats may be killed at any time by owner of property destroyed by them. Muskrat houses are protected at all times. The owner of property destroyed by beavers may appeal to the State game and fish board and have the animals removed (1915, H. B. 300).

Open seasons.—Mink and muskrat, November 16 to April 15. No open season for beaver or otter (1915, H. B. 300). No close season for other fur animals.

Propagation.—The State game and fish board issues permits to breed and domesticate protected birds and animals and also permits to ship them when raised in captivity. Annual reports are required of licensed breeders (1915, H. B. 300).

Bounties.—Wolf or coyote (killed within State), $2.50 each; paid from fund raised by direct taxation on all property (1903, ch. 207).

OHIO.

Trapping.—Written permission required to hunt or trap on lands of another (1915, S. B. 250). The close season for certain fur animals does not prohibit owners or tenants of land from destroying them to protect property. Digging out skunk dens or smoking the animals therefrom is unlawful, as is also the possession of green skunk pelts in close season (1913, H. B. 80).

Open seasons.—Raccoon, November 1 to March 2; muskrat, January 1 to April 2 (1911, H. B. 32); skunk, November 15 to February 2 (1913, H. B. 80); fox, October 2 to January 10 (1911, H. B. 407).

Propagation.—No restrictions, except those which prevent capture of wild stock in close season.

Bounties.—Townships pay a bounty of $1 each on certain hawks (1915, H. B. 79); 20 cents per dozen on English sparrows; and, under certain conditions, 10 cents each on ground hogs (P. & A. Code, 1912, secs. 5824–5827).

OKLAHOMA.

Trapping.—No legal restrictions.

Open seasons.—No close season, except on bears, which may not be killed or captured at any time in Comanche, Caddo, Kiowa, Major, and Blaine Counties (1915, ch. 258).

Propagation.—The State game warden issues permits to propagate fur-bearing animals, game, and fish; cost $2, together with fees for tagging. Licensed breeders may sell and transport animals raised in preserves under rules prescribed by the warden (1915, ch. 185).

Bounties.—County commissioners are authorized to offer bounty on gray wolf ($3) and coyote ($1) (1890, S. B. 458).

OREGON.

Trapping.—License (fee, $1) is required of all persons over 16 years of age to trap on lands not their own. No flesh of game animal or bird may be used to bait traps. Unlawful to remove or disturb traps of a licensed trapper on public domain or on lands where he has permission to trap. Licensed trappers are required to make annual reports of number of animals caught and receipts for fur sold. If beavers or other fur animals damage property, permits to kill them may be obtained from the State board of fish and game commissioners. Skins of such animals are the property of the State, to be sold and the proceeds used in paying for damage to property. Unlawful to destroy muskrat house, except where it obstructs ditch or watercourse (1913, ch. 282).

Open seasons.—Mink, otter, fisher, marten, and muskrat, November 1 to February 28, inclusive. No open season for beaver, and none for fur animals in State game preserve (1913, ch. 232).

Propagation.—Permits to keep fur-bearing animals may be obtained from the State board. No wild fur animals may be taken for propagating purposes in close season nor may those held in captivity under permit be sold in that season. Yearlv reports to the State board are required (1913, ch. 232).

Bounties.—Coyote, $1.50; gray or black wolf, $5 (pup of same, $2.50); timber wolf or timber wolf pup, $2.50; bobcat, wildcat, or lynx, $2; mountain lion, cougar, or panther, $10 (1909, ch. 113); paid by State. The State board is empowered to pay additional bounties, at its discretion, on any predatory animal in order to protect game (1913, ch. 232); under this act the State board now pays for wolf, $20; for cougar, $15.

PENNSYLVANIA.

Trapping.—Unlawful to trap bears, and only one may be killed in a season. No steel traps larger than No. 3 size may be used for trapping wildcats or other fur animals. License not required for trapping, but hunting license required for killing raccoons or bears, which are regarded as "game" animals.

Open seasons.—Bear, October 15 to December 16; raccoon, October 15 to January 1. No open season for beaver. Foxes may not be trapped, shot, snared, or poisoned in Delaware County (1915, P. L., 146).

Propagation.—No legal restrictions on raising fur animals, except that possession and breeding of ferrets is unlawful except under license from the State board of game commissioners; fee for license to breed and sell ferrets, $25; to possess a ferret without breeding, $1 (1915, P. L. 146).

Bounties.—Wildcat, $6; fox, $2; mink, $1; weasel, $1; paid from special fund created by setting aside one-half the receipts by the board of game commissioners from gun licenses, fines, etc. (1915, P. L. 126).

PORTO RICO.

Porto Rico has no wild fur animals.

RHODE ISLAND.

Trapping.—Hunting license is required for trapping, except on one's own lands; fee, resident, $1; nonresident, $10; alien, $15; together with an additional fee of 15 cents for issuing license. Unlawful to trap on posted lands or on lands of another without written permission. Unlawful to set wire snares, or to use steel traps with teeth or with spread over 6 inches, or choke traps with greater opening than 6 inches. Traps must be concealed so as not to endanger domestic animals and must be visited at least once in 24 hours.

Open seasons.—Skunk, muskrat, raccoon, and mink, November 1 to April 15 (1916, ch. 1399). Landowners may kill protected animals on their own lands at any time (1915, ch. 1230).

Propagation.—No legal restrictions.

Bounties.—Fox, $3; crow and certain hawks and owls, 25 cents; paid by State.

SOUTH CAROLINA.

Trapping.—Unlawful to hunt or trap on lands of another without his consent. Unlawful at any time to shoot or trap foxes in York, Union, Chesterfield, Edgefield, Lee, Cherokee, Chester, Fairfield, Lancaster, Richland, Abbeville, Calhoun, Sumter, Orangeburg, and Marlboro Counties. Nonresidents (except freeholders) require license (fee, $5) to chase foxes in Chester, York, Cherokee, and Union Counties (C. Code, Acts 1916, No. 427, sec. 740 and No. 435, sec. 1).

Open seasons.—Fox, in 14 counties (named above), September 1 to February 15 (C. Code, Acts 1916, No. 427, sec. 740 and No. 435, sec. 1).

Propagation.—No legal restrictions.

Bounties.—None paid.

SOUTH DAKOTA.

Trapping.—Hunter's license (fee, $1) required for trapping by resident; trapping license (fee, $10) required for nonresident to take mink, muskrat, otter, or beaver (1909, ch. 183). Persons whose property is damaged by any of these animals may kill them at any time. Muskrats destroying public highways may be killed by town supervisor or person delegated by him. Skins of fur animals killed out of season may not be bought or sold.

Open seasons.—Mink, muskrat, otter, and beaver, November 15 to April 1 (1909, ch. 183).

Propagation.—No restrictions, except that protected animals may not be taken for breeding purposes in close season.

Bounties.—Grown wolf, $5; wolf pup, $2; mountain lion, $3; coyote, $2; paid by State. Should bounty claims for any year exceed the appropriation for that year they are paid pro rata (1905, ch. 177).

TENNESSEE.

Trapping.—Owner of land may hunt or trap on such land at any time; others may do so only with the written consent of owner. Steel traps must be placed at least 12 or more inches within entrance to a hole, cave, den, or hollow log. Traps and deadfalls must be inspected within each 36 hours, and captured animals removed (1915, ch. 152).

Open seasons.—For trapping fur bearers off one's own land, from noon October 15 to noon January 15 (1915, ch. 152).

Propagation.—No legal restrictions.

Bounties.—Wolf or panther, $2 certificate issued by county court, the amount to be applied on payment of taxes (1889, ch. 200).

TEXAS.

Trapping.—No license required for trapping, but on posted lands consent of owner is necessary (1915, ch. 47).

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—Wolf, $2; wildcat, $1; jack rabbit, 5 cents; paid by county, but one-half is refunded by the State, the State, however, being liable only to the extent of its appropriation, which is $100,000 (1915, ch. 47).

UTAH.

Trapping.—No license required for trapping. State fish and game commissioner may trap beavers damaging farms or crops and sell the animals or skins for the benefit of the fish and game fund (1915, ch. 118).

Open seasons.—No close season on fur animals except otters and beavers, which are protected at all times (1915, ch. 118).

Propagation.—No restrictions, except as to otter and beaver. Otters or beavers may be kept in captivity in a licensed private preserve (fee, $25 per year). Permits may be obtained to capture wild animals for stocking a licensed preserve, but one-fourth of the natural increase must be given to the State, and none of the animals may be sold (1915, ch. 118).

Bounties.—Wolf, bear, or mountain lion, $15; coyote, wildcat, or lynx, $1.50; paid from State bounty fund, raised by tax on live stock and by direct appropriation (1913, ch. 92). County commissioners may offer bounty on certain other animals and birds if they think it for the best interests of the county (1903, ch. 7).

VERMONT.

Trapping.—License is required for trapping; fee, resident, 60 cents; nonresident, $10.50. Persons trapping on inclosed lands of another must inform owner of location of traps and must visit traps at least once in 24 hours. The use of spring guns is prohibited, and bear traps must be carefully safeguarded. Skins of fur animals legally taken may be bought or sold at any time. Unlawful to open or destroy a muskrat house or to place a trap at its entrance. Unlawful to dig skunks from dens or to drive them out by use of smoke or chemicals.

Open seasons.—Mink, otter, and muskrat, November 1 to May 1, except that in Addison County the open season for muskrat is during March and April only; marten, raccoon, fisher, and skunk, October 20 to April 1; for trapping foxes, October 20 to April 1 (foxes may be taken otherwise than by trapping at any time). No open season for beaver (1915, ch. 201).

Propagation.—The State fish and game commissioner issues special permits for propagating fur and game animals (fee, $2 and expense of tagging). Animals bred on fur farms may be sold and transported alive at all times when bearing the identification tags prescribed by the commissioner (1915, ch. 231).

Bounties.—Bear, $10; hedgehog (porcupine), 15 cents; paid by State (1912, ch. 207). Towns pay $5 bounty on bay lynx or bobcat (1915, ch. 185).

VIRGINIA.

Trapping.—The following applies to any county after adoption by the board of supervisors: Trapping for fur animals on lands of another is unlawful except from noon of October 15 to noon of January 15, and then only with written permission of landowner, which permission the trapper must have on his person when trapping. He must visit traps at least once in 36 hours and is liable for any damage such traps may do to domestic animals. Landowner may trap or kill fur animals on his own lands at any time (1916, ch. 376).

Open seasons.—(Applies to any county adopting the law.) All fur animals on lands of another, noon of October 15 to noon of January 15 (1916, ch. 376).

Propagation.—No legal restrictions.

Bounties.—Boards of supervisors of counties may at their discretion pay bounties—not over $10 for wolf; $1.50 for wildcat, catamount, or red fox; and 75 cents for chicken hawk or owl (Code, sec. 834).

Local trapping regulations.—The following provisions are in force:

Culpeper County.—Unlawful in Jefferson magisterial district to trap foxes except in November and December. Traps set for foxes must be visited daily to release any dog that may be caught (1912, ch. 257).

Fauquier and Loudoun Counties.—Unlawful to take foxes April 1 to September 1, except by owner or tenant of land to protect property. Unlawful in open season to shoot, trap, or poison foxes except on written authority of a landowner (1914, ch. 141).

Halifax County.—Opossum, open season, October 15 to February 1 (1892, ch. 40).

Loudoun County.—License (fee, $2.50) required to trap mink, muskrat, skunk, opossum, and raccoon on lands of another. Open season for mink, muskrat, and skunk, November 1 to March 1; for opossum and raccoon, October 1 to March 1 (1916, ch. 23).

Nansemond County.—Mink, otter, and muskrat, open season, January 1 to April 1 (1914, ch. 223).

Patrick County.—Wild raccoon or opossum, open season, October 15 to March 15; gray fox, September 15 to March 15 (1912, ch. 247).

Princess Anne County.—Unlawful to catch, trap, or kill mink, muskrat, or otter for profit, except from November 1 to March 15 (1910, ch. 191).

Rappahannock County.—Unlawful to trap or hunt on lands of another without written permit from owner (1910, ch. 361).

Amherst, Essex, King George, and *Loudoun Counties* are authorized to pay bounty of 50 cents each on certain hawks (1916, chs. 7, 124, 336).

WASHINGTON.

Trapping.—No steel trap larger than No. 4 may be used unless a notice in the English language on a large placard is placed above the trap; this requirement does not apply to trapping coyotes (1915, ch. 151).

Open seasons.—No open season for beaver (R. & B. Code 1910, sec. 5395). No close season for other fur animals.

Propagation.—No legal restrictions.

Bounties.—Mountain lion or cougar, $20; lynx or wildcat, $5; coyote, $1; timber wolf, $15 (1909, ch. 193); seal or sea lion, $1 (1915, ch. 31); paid by State. Counties are permitted to pay additional rewards for destroying these animals, and also bounties on bear, muskrat, and squirrel (R. & B. Code 1910, secs. 3587–3592).

WEST VIRGINIA.

Trapping.—An owner of lands or his agent or tenant may hunt or kill protected fur animals on such lands at any time, but it is unlawful to set or maintain a snare or trap upon lands of another without express permission of owner or tenant. Unlawful to set a steel or spring bear trap on lands of another. Hunting license is required for trapping; fee, resident, $3; nonresident, $16.

Open seasons.—Red fox, raccoon, mink, and skunk, November 1 to January 1 (1915, ch. 14). Any county may by majority vote provide a perpetual close season on skunk (1903, ch. 44).

Propagation.—No restriction on possession or sale, but animals may not be taken for breeding purposes in close season except on lands owned or tenanted by the breeder.

Bounties.—Wildcat, bobcat, or catamount, $5; crow, 10 cents; certain hawks and owls, 25 cents; paid from forest, game, and fish protection fund (1915, ch. 14).

WISCONSIN.

Trapping.—License is required for trapping; fee, resident, $1; nonresident, $10. Unlawful to take fisher, marten, mink, or muskrat with the aid of spear, gun, or dog; to take rabbit with ferret; to disturb or molest muskrat houses, or beaver houses or beaver dams, or raccoon den trees for the purpose of capturing raccoons; or to set traps within 500 feet of any beaver dam or beaver house. Steel traps may be used for taking fur animals in open season. The possession of green skins of any fur-bearing animal during close season is unlawful, as is also the possession at any time of the skins of fisher, marten, mink, or muskrat which show that the animals had been shot or speared.

Owners of cranberry marshes may at any time destroy muskrats to protect dams, but they may not sell, barter, or give away the skins of such animals killed during close season.

Beavers and otters are protected at all times. If beavers damage property, they may be captured and removed under the direction of the State conservation commission (1915, ch. 594).

Open seasons.—Fisher, marten, and mink, November 15 to March 16; raccoon, November 1 to February 2 (except in Washington and Ozaukee Counties, November 15 to December 16); muskrat,[1] November 15 to March 16. No open season for beaver or otter. Skunk, open season in Washington and Ozaukee Counties, October 10 to February 2; no close season in other parts of the State (1915, ch. 594, sec. 62.16).

Propagation.—Breeders of protected game or fur animals must obtain a license from the State conservation commission (fee, $5) and make annual reports to the commission. The commission will furnish tags at cost of same to enable breeders to ship, sell, and transport animals or skins from their establishments (1915, ch. 594, sec. 62.51).

Bounties.—Wolf cub taken between March 1 and November 1, $4; mature wolf killed at any time, $10; wildcat or lynx, $3; paid by county. County boards may increase these rewards, but no county may pay more than $6 for killing a wolf cub. The State treasurer duplicates all county awards, thus doubling the above bounties. Poisons may be used for destroying animals for bounty between December 1 and March 1, but notice of putting out baits must be posted, and they may not be placed within 80 rods of a dwelling house. County boards may offer bounty on crow, hawk, pocket gopher, streaked gopher, English sparrow, or rattlesnake (1915, ch. 594, secs. 62.47–62.49).

WYOMING.

Trapping.—Unlawful to trap game animals or birds or to use their flesh as trap bait for predatory animals. Unlawful to trap on State game preserves (1915, ch. 91),[2] and for anyone not employed by the United States Department of Agriculture to trap in national forests within the State without first obtaining a permit (fee, $5) from the State game warden (C. S. 1910, Mullen, sec. 2786). Nonresident of State must secure a special license (fee, $10) to hunt, pursue, trap, or kill bears (sec. 2748).

Open seasons.—No close season on fur-bearing animals except beavers, which may not be taken at any time until September 15, 1919, but if they damage real estate the owner may obtain permit to destroy them (sec. 2769).

Propagation.—No legal restrictions.

Bounties.—Coyote, $1.50; bobcat, $1; adult male gray or black wolf, $7.50 (female, $12, and positive proof of sex required); gray or black wolf pup, $5; mountain lion, $10; paid from State appropriations 1915, ch. 96.

ALBERTA.

[Game act, as amended to 1916.]

Trapping.—Nonresident requires license to trap; fee, $25. Unlawful to use poison for taking fur-bearing animals; to destroy, partially destroy, or leave open any muskrat or beaver house; or to destroy a beaver dam, unless authorized to do so by the lieutenant governor in council, who may also authorize the killing of beavers or other fur animals when such killing is deemed to be in the public interest. Export of unprime skins or pelts is forbidden, unless by permit from the minister of agriculture. No fox may be trapped or taken alive for export. Every company, firm, or person engaged in the fur trade must make annual returns of the numbers of skins bought or sold (game act, 1915).

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[1] Exceptions: (1) In Lake St. Croix, Lake Pepin, Mississippi River, and all inland bays, bayous, and sloughs tributary thereto the open season is March 1 to April 11; (2) in Polk, Barrow, Rusk, Prince, Lincoln, Langlade, Forest, Marinette, Florence, Oneida, Vilas, Iron, Ashland, Sawyer, Washburn, Burnett, Douglas, and Bayfield Counties the open season is November 1 to April 21.

[2] Five State game preserves are defined in a recent act (1915, ch. 105).

Open seasons.—Mink, fisher, and marten, November 1 to April 1; otter and muskrat, November 1 to May 1. No open season for beaver until December 31, 1920, unless locally by order of the lieutenant governor in council (game act, 1915).

Propagation.—No restrictions on propagation, but export of live animals may be made only by permit from the minister of agriculture. The lieutenant governor in council may from time to time make additional regulations regarding buying, selling, and exporting game and fur-bearing animals reared on game or fur farms (game act, 1915).

Bounties.—The council of any rural municipality is authorized to offer a bounty on wolves.

BRITISH COLUMBIA.

Trapping.—License required to trap off one's own lands; fee, resident, $10; nonresident, $100. A licensed trapper who first occupies a trap line prior to November 14 is protected against other trappers. License must be returned within two months after it expires with a statement of number of fur animals of each kind taken. It is unlawful to touch or interfere with traps set by a licensed trapper, to trap on inclosed or cultivated land without permission of owner, or to permit traps to remain set after close of season. Export of pelts is allowed only during open season and for 60 days thereafter (1914, ch. 33). Special license (fee, $25) is required by nonresident to hunt bears.

Open seasons.—Fox, November 1 to March 16; all other fur-bearing animals (beaver, marten, fisher, mink, muskrat, otter, raccoon, and weasel or ermine), November 1 to May 1; except that beaver may not be taken in the electoral districts of Kamloops, Similkameen, and Greenwood (order lieutenant governor in council, Aug. 3, 1916).

Propagation.—A permit to propagate fur-bearing animals is required. Breeder must keep a record of transactions as to purchases and sales of stock, which record must be open to inspection of any game warden (1914, ch. 33). Live foxes may be exported only under permit; fee, $100. Special license is required to take foxes or other fur animals in close season.

Bounties.—Rates fixed from time to time by lieutenant governor in council. Under regulations of October 7, 1914, they are as follows: Mature wolf or cougar, $15; mature coyote, $3 (half as much for young wolf, cougar, or coyote); golden eagle, in Yale, Kootenay, and Cariboo Counties, $3.

MANITOBA.

[From "Game protection act," as amended to 1916.]

Trapping.—A license is required to trap, except on one's own land; fee, residents, 50 cents; nonresident Canadian citizen, $25; nonresident alien, $100. Report giving number of animals of each kind taken under license is required to be made between June 1 and July 1. Persons trading in furs must be licensed (fee, resident, $5; nonresident, $50) and are required to make annual returns before August 1. Unlawful to trap in provincial game preserves, to trap on cultivated or inclosed lands without permission of owner, to destroy a muskrat or beaver house, to use poison in taking fur animals, or to export unprime skins. Poison may not be used to capture wolves for bounty.

Open seasons.—South of fifty-third parallel: Fisher, pekan, sable, marten, and mink, November 1 to April 1; otter, and beaver, no open season; muskrat, November 1 to May 1; fox and lynx, no close season. *North of fifty-third parallel:* Fisher, pekan, sable, marten, mink, otter, and beaver, November 15 to May 1; muskrat, October 20 to June 1; fox and lynx, November 15 to April 1.

Propagation.—No legal restrictions, except that special permit is required to export a live fox from the Province; fee, for black or silver fox, $100; for cross or red fox, $15.

Bounties.—Timber wolf, $5; other wolf, $2; half is refunded to municipality by the provincial treasurer (1915, ch. 95).

NEW BRUNSWICK.

[From " Game act of 1909," as amended to 1916.]

Trapping.—Nonresidents require a license (fee, $25) for trapping. A license is also required to deal in, buy, sell, cure, or tan the skins of fur-bearing animals. The digging out of foxes from their homes or earth burrows is prohibited at all times. Unlawful to possess green skins or carcasses of protected fur animals in close season.

Open seasons.—Mink, otter, fisher, and sable, November 1 to April 1; fox, October 1 to March 1; muskrat, noon of March 25 to noon of May 15. Beaver, close season to July 1, 1917. The surveyor general, when satisfied that a number of beavers may be taken from any stream without injury to the supply, may issue a special license for taking them; fee, $2 for each animal taken.

Propagation.—Permits to capture wild fur-bearing animals for propagation within the Province may be obtained from the surveyor general, who fixes the fee for such permit.

Bounties.—Wildcat (killed within the Province), $1, paid by the surveyor general.

NEWFOUNDLAND.

[From game laws of Newfoundland, 1913, corrected to 1915.]

Trapping.—Nonresident trappers require annual license; fee, $501. Fur buyers and shippers also require annual license (fee, 50 cents), and must report operations under same before December 31 of each year. Trapping on Grand Lake Caribou Preserve is unlawful at all times.

Open seasons.—Otter, marten, and lynx, October 1 to April 1; fox, October 15 to March 15; muskrat, October 1 to May 1. No open season for beaver until October 1, 1918.

Propagation.—No restrictions, except as to foxes. A fox farm must be licensed; the owner must at stated times make reports to the game and inland fisheries board, and the premises must be at all times open to inspection by officers of the board. Possession of fox cub or fox taken in close season is prohibited. Unlawful to export a fox not bred on a fox farm, or, without permit from the colonial board, to export a fox bred in captivity.

Bounties.—None paid.

NORTHWEST TERRITORIES.

Trapping.—Use of poison prohibited in taking fur-bearing animals. Export of low-grade furs forbidden (1903, 2d sess., ch. 29).

Open seasons.—Mink, fisher, and marten, November 1 to May 15; otter, beaver, and muskrat, October 1 to May 15.

Propagation.—No legal restrictions.

Bounties.—None paid.

NOVA SCOTIA.

Trapping.—Nonresident requires a license (fee, $30) to take fur-bearing animals, which are included in the term "game." Unlawful to take any protected fur animal from a burrow or den by smoking, digging, or by use of poison; to damage or molest a beaver dam or house, or a muskrat house, or set snare or trap within 25 feet of the latter; or to have in possession the green hide or pelt of a fur animal taken out of season (1915, ch. 38).

Open seasons.—Mink, otter, fox, raccoon, and muskrat, November 1 to February 1; all other fur-bearing animals (except bear, wolf, and wildcat, which are not protected), November 1 to February 1. No open season for beaver or marten (1915, ch. 38).

Propagation.—Permits to take wild animals may be obtained from the board of game commissioners under such restrictions as they may require. Unlawful to keep fur-bearing animals in captivity for breeding purposes without a permit from the chief game commissioner; fee $2 for each kind of animal kept, payable annually. Reports are required annually on September 30. Inclosures for fur animals are protected from trespass (1912, ch. 59).

Bounties.—None paid.

ONTARIO.

[From Rev. Stat., ch. 262, as amended to 1916.]

Trapping.—License to trap required except on one's own land; fee, resident $5; nonresident $50. License (fee, $2) is required of all fur dealers or traders. Dealers may obtain a permit to hold furs during close season. Muskrats may not be shot or speared at any time. Muskrat houses are protected at all times except when the animals are injuring property. Beavers, when damaging property, may be destroyed by game overseer under special authorization from the superintendent of game fisheries.

Open seasons.—Mink, November 1 to May 1; muskrat, north of French and Mattawa Rivers, April 1 to May 21; south of said rivers, March 1 to April 21; beaver and otter, protected to November 1, 1916, after which date hunting, taking, or killing them permitted only during such periods and on such terms and conditions as may be prescribed by the lieutenant governor in council (1915, ch. 20).

Propagation.—A permit is required of breeders of game or fur animals. Licensed fur breeders may sell live animals or skins at any time. The minister may grant permits to take fur animals during the close season, for propagation and scientific purposes.

Bounties.—Gray timber wolf, $15; other wolf, $5; paid by county, but provincial treasurer refunds 40 per cent to county. Provincial treasurer pays entire bounty in unorganized counties (1916 wolf bounty act).

PRINCE EDWARD ISLAND.

Trapping.—Nonresident requires license (fee, $50) for trapping. Unlawful to put out poisoned baits for foxes or other animals.

Open seasons.—Marten, mink, muskrat, and otter, November 1 to April 1.

Propagation.—Several special acts of the provincial legislature regulate fox ranching on the island. The animals are assessed for taxation (1913, ch. 9) and ranches are protected from trespass, under heavy penalties (1913, ch. 10).

Bounties.—None paid.

QUEBEC.

[From Rev. Stat. 1909, ch. 8, as amended to 1916.]

Trapping.—Reports are required of all persons engaged in the fur trade (buying, selling, or taking fur animals) before September 1 of each year.

Open seasons.—Zone No. 1 (west and south of Saguenay River): Mink, otter, marten, pekan (fisher), fox, and raccoon, November 1 to April 1; bear, August 20 to July 1; muskrat, during April only. Beaver, protected to November 1, 1917; open season thereafter, November 1 to April 1. *Zone No. 2* (east and north of Saguenay River): Mink, marten, and pekan, November 1 to April 1; bear, August 20 to July 1; muskrat, November 1 to April 1; otter, October 15 to April 15; beaver, November 1 to April 1, except in Chicoutimi County, where close season extends to November 1, 1917.

Propagation.—The minister of colonization, mines, and fisheries may grant permits to take animals alive for breeding purposes; nonresidents are charged a fee of from $5 to $25 for such license.

Bounties.—Wolf, $15.

SASKATCHEWAN.

[From Rev. Stat. 1909, as amended to 1916.]

Trapping.—Nonresident requires license (fee, $25) to trap. Unlawful to trap on game refuges; to use poison for taking fur animals; to spear or shoot muskrats, or to destroy muskrat house or beaver dam; to export unprime furs; to buy or sell furs without license (fee, 60 cents); and to ship any fur animal in concealed receptacle. Licensed fur traders must make annual report of operations.

Open seasons.—Mink, fisher, and marten, November 1 to April 1; otter and muskrat, November 1 to May 1; fox, May 15 to February 15; beaver, north of Churchill River, November 1 to May 1; no open season for beaver south of Churchill River until December 1, 1920 (1916, ch. 30).

Propagation.—No legal restrictions, except as to shipping live foxes and capturing young foxes for breeding purposes. Permit to ship live fur animals is required; fee, for black or silver fox, $25; for cross or red fox, $5; for other fur animal, $5. Young foxes may not be taken from dens before May 15.

Bounties.—Timber wolf, $5 (pup, $1); prairie wolf, or coyote, $1; paid only in properly gazetted wolf districts, when half is refunded from provincial treasury (1907, ch. 28).

YUKON.

Trapping.—Use of poison in taking animals forbidden.

Open seasons.—No close season except for young foxes; these may not be taken from April 1 to June 1.

Propagation.—No restrictions other than as to foxes. Registration of fox breeders required. Unlawful to export a fox not born in captivity or which has been in captivity for less than a year; any fox born in captivity may be exported under a permit (fee, $5). Fox and other fur ranches, if posted against trespass, may not be approached without owner's consent.

Bounties.—None paid.

SUMMARY OF FUR PROTECTION.

Beaver.—No open season in 22 States, Alaska, 4 Canadian Provinces and parts of 4 others; close season in 8 States, 1 Province, and parts of 4 Provinces; may be taken under special license in Michigan and New Brunswick; not protected in 17 States and 2 Provinces, the majority of which have no beavers within their borders.

Otter.—No open season in 5 States, 1 Province, and part of 1 Province; close season in 18 States, certain counties of 3 others, Alaska, 9 Provinces, and part of 1 Province; not protected in 22 States.

Muskrat.—Close season in Alaska, 23 States, certain counties of 3 States, and all of Canada except Yukon; muskrat houses and dens protected in 13 States and 5 Provinces; no close season in 22 States and Yukon.

Mink.—Close season in Alaska, 24 States, certain counties in 3 States, and nearly all of Canada; no close season in 21 States and Yukon; bounty in Pennsylvania.

Marten.—No open season in Alaska and Nova Scotia; close season in 7 States and 7 Provinces.

Fisher.—Close season in 6 States and 8 Provinces.

Skunk.—Close season in 18 States and a few counties of 3 others; bounty permitted in Connecticut.

Raccoon.—Close season in 19 States, certain counties of 3 States, and in 2 Provinces; bounty authorized in Arizona.

Opossum.—Close season in 9 States and certain counties of 3 others; not protected in much of its range.

Fox.—Close season in 11 States, certain counties of 4 States, and in 4 Provinces; no open season for trapping fox in Mississippi; bounties paid in 2 States and certain counties of 4 others.

Lynx and wildcat.—Close season in Alaska and Manitoba; not usually protected; bounties paid in 18 States and a few counties of 3 or 4 others. New Brunswick pays bounty on wildcat but not on lynx.

Bear.—Close season in 4 States and (for brown bear) in Alaska; no open season in 5 counties of Oklahoma; open season in British Columbia, dependent on orders in council; bounty on bears paid in 4 States and a few counties elsewhere; special regulations forbidding trapping, or regulating it, exist in several States.

Weasel.—Close season in Alaska and British Columbia; State bounty paid in Pennsylvania and town bounty permitted in Connecticut.

Ferret.—The black-footed native ferret is an exceedingly useful animal, not widely distributed and not legally protected. Domesticated ferrets are used mainly for bolting rats, rabbits, and other animals from dens. A license is required to keep a ferret in Pennsylvania. Their use in hunting rabbits is forbidden by law in Delaware, Illinois, Maine, Maryland, Massachusetts, Michigan, New Jersey, Pennsylvania, and Rhode Island; forbidden, except on one's own premises, in Indiana, Kentucky, New Hampshire, Ohio, and West Virginia, and in Shenandoah County, Va.; forbidden in New York, except in such counties as may have received permission to use them from the conservation commission; also in Vermont, where they may be used to bolt but not to capture rabbits.

Table I affords comparison of the length, in days, of open seasons for trapping the more important fur animals. Alabama, Arizona, Massachusetts, Oklahoma, Texas, Yukon, and the District of Columbia have no close seasons; Colorado, Idaho, Montana, Nevada, New Mexico, Pennsylvania, Washington, and Wyoming have no open season for beavers; California has no open season for beavers and sea otters; and Arkansas and Utah have none for beavers and land otters. Georgia has a close season for opossums only; while Maryland, North Carolina, South Carolina, and Virginia have local county laws that protect certain species by close season.

TABLE I.—*Length (in days) of open seasons for trapping various fur animals, 1916.*

State or Province.	Beaver.	Otter.	Muskrat.	Mink.	Marten.	Fisher.	Skunk.	Raccoon.	Opossum.	Fox.
Alabama	(1)	(1)	(1)	(1)	......	......	(1)	(1)	(1)	(1)
Alaska	0	136	182	136	0	......	......	......	......	105
Arizona	(1)	(1)	(1)	(1)	......	......	(1)	(1)	......	(1)
Arkansas	0	0	(1)	(1)	......	......	(1)	(1)	(1)	(1)
California	0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	......	(1)
Colorado	0	(1)	(1)	(1)	(1)	......	(1)	(1)	......	(1)
Connecticut	......	151	(1)	(1)	......	......	(1)	180	(1)	(1)
Delaware	......	100	[2] 116	100	......	......	100	138	138	212
District of Columbia	......	(1)	(1)	(1)	......	......	(1)	(1)	(1)	(1)
Florida	92	92	......	(1)	......	......	(1)	(1)	(1)	(1)
Georgia	(1)	(1)	(1)	(1)	......	......	(1)	(1)	151	(1)
Idaho	0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	......	(1)
Illinois	......	151	151	151	......	......	151	151	151	(1)
Indiana	......	(1)	151	151	......	......	151	151	151	(1)
Iowa	121	121	121	121	......	......	(1)	(1)	(1)	(1)
Kansas	0	0	121	121	......	......	121	121	121	(1)
Kentucky	46	46	(1)	46	......	......	46	46	46	(1)
Louisiana	107	107	107	107	......	......	107	107	107	107
Maine	0	120	181	120	120	120	120	120	......	120
Maryland [3]	......	......	......	......	......	......	......	......	......	......
Massachusetts	......	(1)	(1)	(1)	......	......	(1)	(1)	......	(1)
Michigan	[4] 195	151	165	151	151	151	151	151	(1)	151
Minnesota	0	(1)	135	135	(1)	(1)	(1)	(1)	......	(1)
Mississippi	47	47	47	47	......	......	47	47	(1)	[5] 0
Missouri	92	92	92	92	......	......	92	92	92	92
Montana	0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	......	(1)
Nebraska	0	59	59	59	......	......	(1)	(1)	(1)	(1)
Nevada	0	(1)	(1)	(1)	......	......	(1)	(1)	......	(1)
New Hampshire	0	120	120	120	120	120	120	120	......	120
New Jersey	0	138	138	138	......	......	138	76	(1)	(1)
New Mexico	0	(1)	(1)	(1)	......	......	(1)	(1)	......	(1)
New York	0	(1)	162	126	126	(1)	93	126	(1)	(1)
North Carolina [3]	......	......	......	......	......	......	......	......	......	......
North Dakota	0	0	150	150	......	......	(1)	(1)	......	(1)
Ohio	......	(1)	91	(1)	......	......	79	121	(1)	100
Oklahoma	(1)	(1)	(1)	(1)	......	......	(1)	(1)	(1)	(1)
Oregon	0	120	120	120	120	120	(1)	(1)	......	(1)
Pennsylvania	0	(1)	(1)	(1)	(1)	(1)	(1)	78	(1)	(1)
Rhode Island	......	(1)	165	165	......	......	165	165	......	(1)
South Carolina [3]	......	......	......	......	......	......	......	......	......	......
South Dakota	137	137	137	137	......	......	(1)	(1)	......	(1)
Tennessee	92	92	92	92	......	......	92	92	92	92
Texas	(1)	(1)	(1)	(1)	......	......	(1)	(1)	(1)	(1)
Utah	0	0	(1)	(1)	......	......	(1)	(1)	......	(1)
Vermont	0	181	181	181	163	163	163	103	......	163

[1] No close season.

[2] Except Newcastle County, open season 100 days.

[3] Local county laws.

[4] Under special license only.

[5] Open season for *chasing* fox, eight months.

TABLE I.—*Length (in days) of open seasons for trapping various fur animals, 1916*—Continued.

State or Province.	Beaver.	Otter.	Muskrat.	Mink.	Marten.	Fisher.	Skunk.	Raccoon.	Opossum.	Fox.
Virginia [1]	......	......	......	......	......	......	......	......	......	......
Washington	0	(2)	(2)	(2)	(2)	(2)	(2)	(2)	......	(2)
West Virginia	......	(2)	(2)	61	(2)	......	61	61	(2)	61
Wisconsin	0	0	121	121	121	121	[3] 115	93	......	(2)
Wyoming	0	(2)	(2)	(2)	(2)	(2)	(2)	(2)	......	(2)
Alberta	0	181	181	151	151	151	(2)	......	......	(2)
British Columbia	[4] 181	181	181	181	181	181	(2)	181	......	136
Manitoba, north part	198	198	224	198	167	167	(2)	......	......	(2)
South part	0	0	212	181	181	181	(2)	(2)	......	137
New Brunswick	[5] 0	151	51	151	151	151	(2)	(2)	......	151
Newfoundland	0	182	212	......	182	......	......	(2)	......	151
Northwest Territories	226	226	226	195	195	195	......	......	......	(2)
Nova Scotia	0	92	92	92	0	92	(2)	92	......	92
Ontario, north part	0	0	50	181	(2)	......	(2)	(2)	......	(2)
South part	0	0	51	181	(2)	......	(2)	(2)	......	(2)
Prince Edward Island	......	151	151	151	151	......	......	......	......	(2)
Quebec, Zone No. 1	0	151	30	151	151	151	(2)	151	......	151
Zone No. 2	151	168	151	151	151	151	(2)	......	......	(2)
Saskatchewan	[6] 181	181	181	151	151	151	(2)	......	......	276
Yukon	(2)	(2)	(2)	(2)	(2)	(2)	......	......	......	(2)

[1] Local county laws.
[2] No close season.
[3] Two counties only; no close season in others.
[4] No open season in southern part.
[5] Except under special license.
[6] No open season south of Churchill River.

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ANTHRAX OR CHARBON

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FARMERS' BULLETIN 784

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry

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ANTHRAX, or charbon, is an acute infectious disease affecting animals and occasionally man. Cattle and sheep are most susceptible, and none of the domestic animals are exempt.

It is caused by a germ which multiplies rapidly in the body, especially in the blood, and produces poisonous substances which cause death. The germs probably are most commonly taken in with food, though they may gain entrance also through wounds. In what is known as the spore form they are very resistant to heat, cold, and disinfectants, and may survive in the soil for years.

The symptoms of anthrax vary greatly, according to the acuteness of the attack. The early stages usually are characterized by high fever, rapid pulse, and labored breathing. In the most common form of the disease there are also local external swellings or tumors. Death ensues in from a few hours to several days.

Medicinal treatment is usually of no avail in acute cases. When the progress of the disease is not too rapid, the injection of antianthrax serum will often bring about a cure, but at present this serum is not readily obtainable.

The most effective method of dealing with anthrax is by prevention. The preventive measures recommended are (1) protecting individual animals by vaccination and (2) burning or deeply burying the carcasses of animals that have died of the disease, so as to avoid infecting the ground. Full information and directions are given in this bulletin.

ANTHRAX OR CHARBON.

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DESCRIPTION AND SYNONYMS.

Anthrax, variously known as charbon, splenic fever, or splenic apoplexy, when occurring in animals, and in man as malignant pustule, malignant carbuncle, or woolsorter's disease, is an acute infectious disease caused by a certain kind of germ, and as every species of domestic animal is susceptible to its attacks the disease might become one of the greatest scourges of animal life. Man is by no means immune, although fortunately the malady as it appears is usually less acute than the form seen in cattle and sheep. This is probably because the lesions in man occur most frequently from infection of the surface of the hands or feet, while cattle and sheep are more likely to swallow the infectious germs with their feed, thus giving the germs immediate entrance into their systems, where they exert their most harmful influence without check or control.

HISTORY.

Anthrax of cattle was known in southern Europe as early as 1613. It spread to the people and ultimately became a scourge, causing more than 60,000 deaths. It is evident the disease was far more virulent and inclined to attack all species of mammals during earlier times than now. During the early periods many deer and other game were destroyed.

The specific cause of anthrax, microscopic bodies in the blood, was discovered in 1850, and from this investigation by Davaine has grown all that is now known of this important scientific subject. Later it was asserted by Koch that natural infection occurred through the intestinal tract, although he was unable to demonstrate it.

CAUSE OF THE DISEASE.

The microscopic organism causing anthrax is known as the anthrax bacillus. In form it is cylindrical or rodlike, measuring one five-thousandth to one two-thousand-five-hundredth inch in length and one twenty-five-thousandth inch in diameter. Like all bacteria these

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NOTE.—This bulletin supersedes Farmers' Bulletin 439 on the same subject, and is intended to give valuable information to all who have anything to do with domestic animals.

rodlike bodies have the power of indefinite multiplication, and in the bodies of infected animals they cause death by rapidly increasing in numbers and producing substances which poison the body. In the blood they multiply in number by becoming elongated, and then dividing in two, each new organism continuing the same process indefinitely. Outside the body, however, they multiply in a different way when under conditions unfavorable to growth. Oval bodies, which are called spores, appear within the rods, and remain alive and capable of germination after years of drying. They also resist heat to a remarkable degree, so that boiling water is necessary to destroy them. The bacilli themselves, on the other hand, show only very little resistance to heat and drying. This characteristic may be likened to a blade of corn, which may be destroyed very easily by the application of heat or cold, while the seed or spore will resist considerable heat and is unaffected by freezing. It is also very resistant to the action of disinfectants.

The anthrax bacilli in the blood of an animal at the time of its death seldom form spores if the carcass is buried promptly, without having been opened to permit the entrance of air. In this event they are destroyed quickly; hence the advantage of the early and deep burial of all animals that die from the disease.

It has long been known that the anthrax virus thrives best under certain conditions of the soil and on territories subject to floods and inundations. The particular kinds of soil upon which the disease is observed are black, loose, warm, humous soils, also those containing lime, marl, and clay, and finally peaty, swampy soils resting upon strata which hold the water, or, in other words, are impervious. Hence fields containing stagnant pools may be the source of infection. The infection may be limited to certain farms, or even to restricted areas on such farms. Even in the Alps. at elevations of more than 3,000 feet above sea level, where such conditions prevail in secluded valleys, anthrax persists among herds.

SYMPTOMS.

The symptoms of anthrax vary with the kind of animal and type of disease, except that in the last stages the most pronounced symptoms are identical. In the first or most acute of the three types (*anthrax peracutus*) the animal may appear at the outset to be perfectly well and keep with its fellows even when its temperature is very high—as high as 106° F. With such a temperature there is, of course, a rapid pulse and increased respiration. When one is standing close the heart beats may be plainly heard. Other symptoms are tremors, grinding of the teeth, and standing with head down; afterwards drooping of the head and ears and a disposition to lie down are noticed. Animals that have been lively will decline to rise unless handled roughly and become stupid, sleepy, and very weak in the hind parts. Whereas, the temperature has all along been high it now shows a sharp decline, and before death may be below the normal. The symptoms in cattle vary considerably, depending upon whether the disease begins in the skin, lungs, or intestines; they depend also on the severity of the attack. Thus in this first, or apoplectiform type, the animal dies very suddenly, as if from apoplexy. Such cases usually occur in the beginning of an outbreak. The animal, without having shown any signs of disease, suddenly drops in the pasture and dies in convulsions, or an animal apparently well at night is found dead in the morning.

The second type (*anthrax acutus*), without any external swellings, is the one most commonly observed in cattle. The disease begins with a high fever. The temperature may reach 106° or 107° F., with pulse beats from 80 to 100 a minute. Feeding and rumination are suspended. Chills and muscular tremors may appear and the skin show uneven temperature. The ears and base of the horns are cold, the coat staring. The animals are dull and stupid and manifest great weakness. To these symptoms others are added in the course of the disease. The dullness may give way to great uneasiness, champing of the jaws, spasms of the limbs, kicking and pawing the ground. The breathing may become labored. The nostrils then dilate, the mouth is open, the head raised, and all muscles of the chest are strained during breathing, while the visible mucous membranes (nose, mouth, rectum, and vagina) become bluish. If the disease has started in the bowels there is much pain, as shown by the moaning of the animal; the discharges, at first firm, become softer and covered with serum, mucus, and blood.

As the disease approaches the fatal termination the weakness of the animal increases. It leans against supports or lies down. Blood vessels may rupture and give rise to spots of blood on the various mucous membranes and bloody discharges from nose, mouth, rectum, and vagina. The urine not infrequently contains blood (red water). Death ensues within one or two days.

The third form of anthrax, the subacute, produces symptoms like those of the acute form except that they are of slower development. Instead of becoming established in 12 to 24 hours one to seven days may be required. The fever is very high. Serious colics are often present. Local anthrax tumors appear externally, first near the shoulders, neck, and head, and are usually caused by local injury or bruising, which gives rise to a collection of bacilli within the blood vessels of the part, thus inducing inflamation which results in the swellings or carbuncles. These tumors are at first hard and fixed, but later become cold, insensible, diffuse, and fluctuating.

An examination of the carcass of an animal dead of anthrax of the subacute form will probably show many lesions or alterations. Hemorrhages may be found in almost all parts of the body. Serous infiltrations (watery diffusions) may be present beneath mucous membranes and skin. There will be swelling of the spleen, liver, and kidneys and the blood will be of a muddy or tarry appearance and will not clot. The cavities of the body contain more or less bloody fluid, and the lymphatic glands are swollen and contain small hemorrhages. The red blood cells have broken down in large numbers and the serum of the blood has been markedly reddened. The walls of the intestines may appear perfectly normal, but hemorrhages are frequently seen, especially in the walls of the duodenum.

The subacute form is the one most commonly met, and it is the only form which responds favorably to treatment. Death ensues so quickly in the other two forms that attempts at treatment are of but little use.

Isolated or sporadic cases are usually of the subacute form, and are frequently limited to the formation of a tumor or carbuncle at the point of the body at which the infective germs first gained their entrance.

SUSCEPTIBILITY OF VARIOUS ANIMALS.

Cattle and sheep are very susceptible to infection with anthrax, and none of the domestic animals are exempt. Horses and mules contract the disease, but less readily than cattle or sheep. It is reasonable to suppose that the compound stomachs of the latter animals aid in their infection. The food passes slowly from one stomach to another, allowing time for the multiplication of any spores of anthrax that may have been swallowed with the food, until finally a dangerous number of anthrax germs are cast from the digestive tract into the blood stream, where they are in a position to cause the sudden death of the animal.

Swine are less susceptible than cattle or horses, yet if allowed to eat the carcasses of animals dead from anthrax they may contract the disease. The throat of the hog is usually the part that first shows evidence of an attack of anthrax.

Dogs and cats are still less liable to contract the disease. As with hogs, the first swellings are usually seen in the region of the throat.

Chickens are seldom affected, but if they are, the disease runs a very rapid course, producing death in 24 hours. Anthrax swellings may be seen on the comb and wattles and around the eyes.

ANTHRAX IN MAN (MALIGNANT PUSTULE, OR CARBUNCLE).

Anthrax may be transmitted to man in handling the carcasses and hides of animals which have succumbed to the disease. The infection usually takes place through some abrasion or slight wound of the skin into which the anthrax spores, or bacilli, find their way. The point of inoculation appears at first as a dark point or patch, compared by some writers to the sting of a flea. After a few hours this is changed into a reddened pimple, which bears on its summit, usually around a hair, a yellowish blister, or vesicle, which later becomes red or bluish in color. The burning sensation in this stage is very great. Later this pimple enlarges, its center becomes dry, gangrenous, and is surrounded by an elevated discolored swelling. The center becomes drier and more leatherlike and sinks in as the whole increases in size. The skin around this swelling, or carbuncle, is stained yellow or bluish and is not infrequently swollen and doughy to the touch. The carbuncle itself rarely grows larger than a pea or a small nut and is but slightly painful.

Anthrax swellings, or edemas, may be found in man, and they are at times so extensive as to produce distortion in the appearance of the part. The color of the skin over these swellings varies according to the situation and thickness of the skin and the stage of the disease, and may be white, red, bluish, or blackish.

As these carbuncles and swellings may lead, sooner or later, to an infection of the entire body, and thus be fatal, surgical assistance should at once be called if there is well-grounded suspicion that it may be a case of anthrax.

To show that the transmission of anthrax to man is not so very uncommon, the following figures are taken from the report of the German Government for 1890: The attention of the authorities was brought to 111 cases, 11 of which terminated fatally. The largest number were attributed to the slaughtering, opening, and skinning of animals affected with anthrax. Hence the butchers suffered most extensively. Of the 111 thus affected, 36 belonged to this craft.

In addition to anthrax of the skin (known as malignant pustule), human beings are subject, though very rarely, to the disease of the lungs and the digestive organs. In the case of the lungs the spores are inhaled by workmen in establishments in which wool, hides, and rags are worked over, and it is therefore known as woolsorter's disease. In the case of the digestive organs the disease is contracted by eating insufficiently cooked flesh of diseased animals. These forms of the disease are more fatal than those which start from the skin.

DISTRIBUTION OF ANTHRAX.

At present cattle and sheep are the chief sufferers, and outbreaks appear to be limited to animals that run upon low, moist lands of a more or less mucky character. In certain regions, where the land is mainly hilly, it has been found that anthrax appears every season among cattle in pastures containing wet, low places. When good fences are built around them, however, and the stock is kept upon the dry portions of the pasture, the disease quickly disappears. Should the fence be broken down, allowing cattle to invade the infected area at certain seasons of the year, they are very likely to contract the disease. In fact, certain plots of ground of this description have been found to retain the germs of anthrax for several years, a circumstance which has led many investigators to declare that the organism is capable of growing from year to year without any artificial aid or cultivation, if only planted upon suitable soil; that it will sprout and grow, producing the plant and later the seed, thus providing a perpetual source of infection for the stock that may be allowed on this area of growing anthrax plants.

Because of the remarkable tenacity with which certain plots of ground retained their infection, Pasteur in 1880 reached the conclusion that the carcasses of animals dying from anthrax, even though buried deep, retained their many infectious germs and supplied them with so much nutriment that they continued to multiply for years, and in this way produced an immense underground supply of virulent organisms. Later investigations by Kitasato have shown that, at a depth of 18 to 20 inches below the surface of the ground, spore formation by anthrax bacilli is very incomplete and that at greater depths it must be further suppressed by the presence of the products of decomposition. Koch also has stated that earthworms are incapable of taking up anthrax spores and bringing them to the surface.

Nevertheless the fact remains that certain areas of ground remain dangerous to stock from year to year. It is still an unsettled question whether the anthrax germs grow and multiply each season upon infected lands when conditions of moisture and warmth become favorable or whether the ground becomes infected at some certain time with bacilli, developing spores which remain near the surface of the ground for years or until taken up by some susceptible animal. Careful experiments have shown that anthrax bacilli flourish and retain their virulent properties in stagnant water for at least 12 months, and certain authorities say they have observed them multiplying with no other nourishment than that afforded them by muddy water.

A consideration of some of the most seriously infected localities in this country will help to explain the conditions which tend to perpetuate the infection. Upon the rice plantations of the South, where the fields are annually submerged to favor the starting of the rice plants, many of the animals used in the cultivation of the crops contract anthrax and die as a result if driven over the infected lands after the water has subsided and a few days of hot weather have intervened.

If tanneries are built upon or near streams there is great danger that anthrax will be brought to them upon hides and then be scattered over the lowlands lying downstream from the point where the tanning process is carried on. This state of affairs especially exists near those tanneries which work upon goat or sheep pelts from foreign countries. Infection in the form of spores adheres to these hides so persistently that ordinary fumigation fails to destroy it, and repeated outbreaks of the disease occur wherever such skins are handled.

Aside from the danger of direct infection to animals pasturing on infected areas, there exists the possibility of infection by means of hay or other crops that have been grown upon infected areas of land. The process of drying and curing the hay or forage does not lessen this danger, for drying favors the development of spores, which, mingling with the dust and fragments of the dried forage, may be taken up by the wind and blown about, or may cause serious damage if eaten by susceptible animals.

DIAGNOSIS.

To distinguish between the apoplectic form of anthrax, cerebral hemorrhage, and sunstroke is a most difficult matter. In the less acute cases of anthrax swellings may develop and bloody urine may be noted; these indicate anthrax, although malignant edema, hemorrhagic septicemia, and Texas or tick fever often present symptoms that are so similar as to lead to confusion.

Distinction from blackleg may be made by noting the swellings beneath the skin which appear upon the animal. Those of blackleg are found to crackle under pressure with the finger, owing to the presence of gas within the tissues, while the tumors of anthrax, being caused by the presence of serum, are entirely free from this quality and have a somewhat doughy consistence. The tumors of blackleg usually are found on the shoulder or thigh and are not so frequent about the neck and side of the body as the swellings of anthrax. The blood of animals dead of blackleg is normal, and the spleen does not appear swollen or darkened, as in animals affected with anthrax.

The chief differences between anthrax and Texas or tick fever are that the course of the former is more acute and the blood of the animal is dark and of a tarlike consistence, while in the latter it is thinner than normal. The presence of fever ticks on the cattle also leads one to suspect tick fever in regions where cattle are not immune from the disease.

The anthrax bacillus is larger than many other forms of bacteria, and possesses a characteristic form which helps in its identification by means of microscopic examination. In order to make a definite diagnosis, however, it is quite necessary that the material to be examined reach the laboratory before degeneration has taken place. Six or eight drops of blood drawn from an animal soon after death, collected and allowed to dry upon the concave side of a piece of broken glass from a fruit jar or bottle, affords the most satisfactory sample for laboratory investigation. If this manner of preparing suspected blood is not feasible the sample may be spread thinly upon a piece of window glass. In either case the samples should be allowed to dry thoroughly while separated and may then be packed in a box for mailing. Blood in bulk should not be shipped by mail or express. The container is liable to be broken in transit, in which case the scattered blood offers a serious menace to all who handle it. If shipped in a bottle it may also rapidly decompose, with the result that by the time it has reached the laboratory the anthrax bacilli have disappeared and diagnosis from that sample will be impossible. If the blood is dried upon glass before shipping, the germs within it will remain unchanged until removed for examination. Furthermore, if blood is shipped in bulk, numerous forms of bacteria which produce decay will develop before its destination is reached; these resemble the anthrax bacillus so closely that no definite conclusion can be obtained. Similar changes occur in visceral organs if shipped in cans or jars, and therefore the shipment of such material should never be attempted. A satisfactory way to do in such case is to remove part of an ear of a suspected carcass, wrap it in cheesecloth which has been dipped in a solution of corrosive sublimate prepared by mixing 1 part of corrosive sublimate with 1,000 parts of sterile water and send it by mail or express to a laboratory for examination.

ANATOMICAL CHANGES.

Early in the development of the disease hemorrhages form beneath the mucous membranes of the large organs of the body. Swellings appear in the tissues beneath the skin, which consist of a jellylike mass, yellowish in color and more or less tinged with blood. The lymphatic glands become swollen and softened. If cut, their exposed surfaces display numerous minute hemorrhages. Swellings may appear in the mouth, upon the tongue, or in the rectum. The bodies of animals that have died of anthrax soon lose their rigidity and become bloated, because decomposition sets in very rapidly. Blood-stained fluid flows in small quantities from the mouth, nose, and anus. When the carcasses are opened and examined, it will be found that nearly all the organs are sprinkled with spots of blood of various sizes. The spleen is enlarged to from 2 to 5 times its normal size, and it will be noted that its pulp is blackish, soft, and occasionally disintegrated. The blood is of a tarry consistency, will not clot firmly, and is blackish in color. The lungs are congested and distended with serum. The small intestines and stomach may show areas that are intensely red, with blackish-red blood spots. Similar areas may be present upon the walls of the abdomen. If the brain is examined it usually appears congested and spotted with blood. The hemorrhages and ulcers that are present in the carcass of an animal dead of anthrax generally present an unusual appearance, caused by the swollen area surrounding them, in which jellylike material collects.

In hogs the lesions are chiefly found in the region of the neck and throat. Here marked watery and bloody swelling of the tissues of the throat is in evidence. The tonsils are often covered by a yellowish coating and are greatly swollen. The spleen from a hog's carcass usually presents a normal appearance, but it may be swollen and softened. Intestinal lesions of anthrax are rarely found in hogs.

In certain European abattoirs anthrax in one or more of the intestinal glands of swine has recently been observed. In these cases a fluid exudate surrounding the bloody and swollen lymph glands represented the only signs of the disease that were found in the affected animals.

TREATMENT.

Medicinal treatment of anthrax in animals has not proved satisfactory. In cases of local anthrax, incision of the swelling followed by the application of disinfectants sometimes gives good results. In such cases, however, the danger of disseminating the infection through discharges from the wound would tend to make this inadvisable, unless great care is taken.

As is hereinafter shown, good results have been obtained from the use of serum in the treatment of the disease. For this purpose 30 to 100 cubic centimeters should be administered beneath the skin or into a vein. If no improvement is noticed within 24 hours the injection should be repeated. In a number of instances afforded to test the curative value of the bureau serum in cases of anthrax in man and in animals splendid results were obtained.

PREVENTIVE VACCINES.

In studies of the various infectious diseases it has been found that one of the most desirable means of preventing their extension is to furnish the susceptible and exposed animals with artificial immunity. This is the case with tuberculosis, blackleg, anthrax, rabies, hog cholera, Texas or tick fever, and the like. Many animals prove to be naturally immune from these diseases, while others must be made so by inoculation with suitably prepared materials. Investigators the world over have expended a vast amount of effort and study in attempts to discover and perfect the most effective and at the same time the most practicable means of making animals immune from the more destructive of the infectious diseases. Immense amounts of money, both from governmental sources and from gifts of private wealth, have been appropriated for the advancement of these researches. The goal sought by these searchers along lines of agricultural interest is the discovery of some means by which immunity may be conveyed readily to a large number of animals and at slight expense.

The successful vaccination of cattle against any of these infections must consist in giving the animals so severe an attack that it will strengthen the body tissues in such a way that no great number of germs can find lodgment and nurture there. After such vaccination the animal is fully protected and can go with perfect safety into localities that would have been deadly before the vaccination was performed.

Just how this immunity is obtained is still an open question, but it is manifest that the attenuated organism is able, by its growth, to affect the tissues (some say the animal cells, others the fluid tissues) in such manner that virulent organisms of the variety presented in the vaccine can not possibly thrive therein, and without the rapid multiplication of virulent organisms within the animal tissues there can be no infection.

PASTEUR VACCINE.

Beginning with a thrifty culture of anthrax bacilli growing in a flask of bouillon, Pasteur, in 1881, by a series of experiments found that subjecting it to a temperature of 108.5° F. for 12 days would so lower the virulence of the organisms that they would only exceptionally cause death when injected into rabbits. Continuing the attenuation by subjecting the bacilli to the same degree of heat for 12 days longer, or 24 days in all, he discovered that he had in his possession a living culture of anthrax bacilli that had lost its power for killing cattle, sheep, rabbits, or guinea pigs, although still capable of killing white mice. This was the beginning of the practical preparation of anthrax vaccine, for he soon found that cattle or sheep when inoculated with the culture of 24 days' heating would survive the treatment and would gain a very material power in resisting infection from inoculations with bacilli of a high degree of virulence. This power of resistance is needed to enable them to withstand the injection of the second and stronger vaccine, which, having been subjected to heat for only 12 days, is possessed of considerable virulence.

In his early investigations he made experiments upon a flock of 50 sheep. Half of these were vaccinated with his weakened culture of anthrax bacilli. Twelve days later they received an inoculation with stronger vaccine, and 40 days after this the whole flock was inoculated with a virulent anthrax culture. Two days later the vaccinated animals were all sound, while the checks, those not vaccinated, were all dead.

Following this striking demonstration by Pasteur, 60,000 sheep and 6,000 cattle were at once treated in France. The following year the same form of treatment was applied to 270,000 sheep and to 55,000 cattle. Since that time this method of vaccinating against anthrax has found very general application in France whenever losses have occurred, making it evident that certain fields or pastures have become infected with the disease. As a result, Nocard and Leclainche state that anthrax has disappeared from many sections in which it formerly decimated the live stock and that the medical authorities at the same time reported a disappearance of malignant pustule from among their human patients.

In the Pasteur method of vaccination there are, however, disadvantages which must be duly considered. To obtain satisfactory results from the use of Pasteur's vaccine it is of primary importance that the product be active. Experience has proved that this type of vaccine, if subjected to unfavorable conditions, may deteriorate within a short time after its preparation. Since the enactment of legislation giving the United States Department of Agriculture control of the manufacture of veterinary biological products going into interstate trade, periodical tests have been conducted with anthrax vaccine prepared by various manufacturers, and in many instances the vaccine proved inert within 3 months of its preparation. In other cases it remained potent for a year. When exposed to warm temperature and light it deteriorates very rapidly, and when it is remembered that the products of manufacturers may be stored under unfavorable conditions in branch houses and in rural drug stores, the loss of value can be readily explained.

Then, too, it must be considered that vaccination by Pasteur's method requires two handlings of the animals; that the fullest degree of immunity is not obtained until possibly a week or 10 days after vaccination; that the losses from vaccination are not insignificant; and that the administration of the vaccine in herds where the disease has not yet made its appearance is liable to induce the disease through the reduction of the resistance of the animal during the development of immunity in the process of vaccination.

Other investigators, fearing to use the living anthrax bacillus, even though greatly attenuated, turned their attention to the production of a serum that should possess immunizing powers equal to those of the attenuated organism. The immunity provided by serum inoculations becomes effective very quickly, but does not last long unless reinforced by the addition of virulent material at about the time that the serum is injected.

SERUM VACCINE, SOBERNHEIM'S METHOD.

Very interesting facts have been revealed through the efforts of various investigators to perfect serums for immunizing in outbreaks of anthrax. It is well known that a very small quantity of virulent blood will serve to convey the disease from an anthrax carcass to a healthy animal. A fly can easily carry enough on its proboscis to kill a horse. It may safely be admitted that a single drop is sufficient to cause the death of a horse; yet Sobernheim, by means of repeated injections, using cultures gradually increasing in virulence, has produced such a high degree of immunity in a horse that it withstood the injection into its veins of 500 cubic centimeters (about 17 fluid ounces, or more than a pint) of the most virulent anthrax culture obtainable. This is a good illustration of the meaning of "immunity." It is something that the horse in question received into his system through the several inoculations that enabled him to receive unharmed an injection of living anthrax fully 10,000 times as large as the amount that would have sufficed to kill him before his immunization.

The method devised by Sobernheim possesses the advantage of requiring but a single application, thereby avoiding the inconvenience of restraining the animals at different times for the administration of vaccines or remedies, and its effects are more quickly manifested than those of the double vaccination. The animals receive simultaneous injections of immune serum upon one side of the body and anthrax culture on the other side, the latter being very similar in virulence to Pasteur's second, or stronger, vaccine. Vaccination by this simultaneous method is usually followed by a slight elevation of temperature and diminished appetite. A swelling frequently develops at the point of the injections. In many instances the nasal membranes exhibit considerable swelling, and inflammatory eruptions of the skin are often observed.

The only criticism to be made of Sobernheim's method is that the type of vaccine used in conjunction with the serum, being similar to Pasteur's vaccine, does not possess any better keeping qualities. Thus, if an inert vaccine should be administered together with the serum, the duration of immunity would be no longer than that obtained if serum alone were injected.

BUREAU OF ANIMAL INDUSTRY SERUM AND SPORE VACCINE.

The Bureau of Animal Industry has done considerable work with a view to perfecting a satisfactory method for vaccinating against anthrax.

Several horses were vaccinated against the disease and then hyperimmunized by first injecting them with very minute quantities of virulent anthrax culture (1/200 of a loopful) and gradually increasing the quantity injected until they could withstand the injection of the growth from 6 to 8 large mass cultures of the organism. These horses were then bled and on testing the serum it was found to be highly potent.

The next step was to prepare a reliable vaccine to be used simultaneously with the serum. For this purpose the bureau has prepared a spore vaccine that possesses far better keeping qualities than anthrax vaccine made after Pasteur's method. Furthermore, such a vaccine may be accurately standardized, since a definite number of spores can be placed in each dose. Numerous experiments and field tests have demonstrated that animals given an injection of serum on one side of the body, followed immediately with an injection of spore vaccine on the other side, were given an immediate immunity from anthrax which persisted as long as that conferred by other methods of vaccination.

This method has several decided advantages over the other methods of vaccination against anthrax. The animal is rendered immune almost immediately following vaccination; it need be handled but once; the losses following vaccination are reduced to practically nothing; and the vaccine, being the spore form of the organism suspended in a saline solution, will remain potent for a long time and will resist conditions which would be detrimental to other forms of vaccine.

In using this method of immunization it has been found that 10 cubic centimeters of a potent serum injected subcutaneously on one side of the body, followed immediately with a subcutaneous injection of 1 cubic centimeter of spore vaccine on the other side, is sufficient to immunize cattle, horses, and mules from the disease. In all forms of vaccination against anthrax in sheep the greatest care must be taken, since these animals are highly susceptible to the disease. It is therefore advisable to give a sheep 10 cubic centimeters of serum and only one-fourth of a cubic centimeter of the spore vaccine.

When vaccinating a herd against anthrax, if there is reason to believe the disease is present it is advisable to take the temperature of the animals. Those showing high temperature should be separated from the others and given the serum alone in doses from 30 to 100 cubic centimeters, depending on the severity of the infection. The others in the herd may then be given the simultaneous treatment. Animals given serum alone should be revaccinated after several weeks with both the serum and vaccine.

CARE IN HANDLING VACCINE.

The vaccine used in immunizing from anthrax has many dangerous properties, since it contains living anthrax organisms; hence it should never be used except where the disease has already appeared, and only by qualified veterinarians, as careless handling may result in the serious extension of the very disease that it is desired to eradicate. Vaccines and serum for this work should be obtained from reliable manufacturers, as the use of weakened or diluted material can only lead to disappointing results.

The season of the year in which the vaccination is undertaken makes considerable difference in results, for it has been shown that there is a natural tendency toward the suppression of the disease in the infected regions during the winter months. Animals that are to be pastured in fields known to be infected with anthrax should be vaccinated about a month before being turned out. It is very important to protect vaccinated animals from exposure to severe weather, as harmful results may follow conditions which tend to lower their powers of resistance.

OTHER PREVENTIVE MEASURES.

In future attempts to eradicate anthrax from infected districts preventive inoculation will undoubtedly play a very important part, but, in addition to the vaccination, there are many other steps which should be taken into consideration. Infected areas should be thoroughly drained and kept under cultivation for some time before attempts are made to pasture stock upon them. Sunlight greatly hinders the development of anthrax bacilli, and the repeated stirring of the soil favors the action of the sun's rays.

The complete destruction of all anthrax carcasses is also a very important matter. This is best accomplished by burning, but as this is impracticable in many localities deep burial may be practiced instead.

Covering the carcasses when buried with quicklime adds another valuable precaution against dissemination of the infection. No animal dead from anthrax should ever be skinned or cut open, as the blood from such sources is one of the most dangerous means of spreading the infection, since it contains great numbers of bacilli which quickly turn into spores as soon as spread about upon the face of the ground. All discharges from the body openings should also be burned or buried deeply, as they are frequently of a virulent character.

One of the most common obstacles to sanitary control of outbreaks of anthrax is the opposition of the animals' owners to any regulation requiring them to dispose of the carcasses in a safe and satisfactory manner. Many localities have no legal enactments demanding suitable destruction of infectious carcasses. Not infrequently carcasses filled with deadly material are allowed to lie about in the fields, to be scattered by prowling dogs or birds; or they may be dragged to the nearest stream and thrown into the water, in which case they are floated along, bearing their infection to neighboring properties.

DISPOSAL OF CARCASSES.

It is imperative to burn or bury all carcasses of animals dead from anthrax if the eradication of the infection is ever to be effected.

While the majority of farmers recognize the advisability of burying the carcass promptly, there are some who allow it to lie and decompose or be eaten by dogs and buzzards. Parts of the carcass may be carried by dogs to adjoining or distant pastures, thus spreading the infection. Spores forming in the carcass opened in this way may be carried upon the feet or bills of buzzards and permanently infect pastures miles away. The soil upon which such an animal has lain would certainly be infected and remain so for many years.

During the last few years deep burial, rather than cremation, has been practiced, with good results so far as can be ascertained. While cremation properly carried out is undoubtedly the safest method of disposing of an anthrax carcass, it is practically impossible to destroy absolutely all vestiges of the body and bacilli-laden body fluids, and unless this is done the whole operation so far as it goes is almost a useless waste of time, material, and labor. In the cremation of a carcass in the field even the earth upon which it has lain should be thoroughly and deeply burned over so that the heat will penetrate to a depth sufficient to kill the anthrax bacilli that certainly passed into the soil with the body fluids when rupture occurred from the heat. Enough is known of the biology of the anthrax bacillus to take advantage of the fact that if it is kept in the closed cavities and blood vessels of the body where no air can reach it, not only will the bacilli fail to produce the resistant spore but they will actually become noninfectious and die following the decomposition of the tissues around them.

SEED-FLAX PRODUCTION

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FARMERS' BULLETIN 785

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

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FLAXSEED is produced principally in Minnesota, North Dakota, South Dakota, and Montana. Since 1909 the production of flaxseed has not equaled the demand, and in 1915 it was little more than half the quantity required by the linseed crushers of the United States.

Flax for seed can be grown profitably on breaking, either of native or tame grass sod, and on old land in the upper Mississippi Valley.

Good, clean commercial seed, if well graded and treated with a formaldehyde solution to prevent disease, can be sown where flax diseases are not serious. Where these diseases are specially destructive it is desirable to grow some of the disease-resistant types.

Sow flax on clean land. If grown in rotation with other crops it should follow corn or some other cultivated crop rather than any of the small grains.

Sow with a grain drill on a firm seed bed with a fine surface. To insure satisfactory germination do not sow too deep. An inch is deep enough if there is sufficient moisture for germination at that depth.

Sow early. The seed should be sown as early in spring as the land is prepared and before the surface becomes dry. Sow from 15 to 35 pounds of seed to the acre.

On the small farm, harvest flax with a grain binder. When bound and shocked, the grain is kept from the damp earth and dries more readily after rains. Often the binding attachment is removed, a buncher attached, and the flax dumped in loose bunches on the ground. Sometimes the header can be used to better advantage than the binder in harvesting large acreages. Either the heads are then stacked or a buncher attachment is used and the heads dropped in large bunches.

Keep flax as dry as possible until it is thrashed. The seed flax should be kept from the wet ground, and if stacked should be protected from fall rains.

Keep only clean, plump seed for sowing.

SEED-FLAX PRODUCTION.

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INTRODUCTION.

Flaxseed production in the United States has always been a pioneer industry. This is due to the fact that the crop does well on new breaking, is readily marketable, and brings a high price in proportion to its bulk. Further, when this crop is grown continuously for several years on the same land certain diseases are likely to become so destructive that the returns are not sufficient for profit. In 1850 the leading States in the production of flaxseed were Ohio and Kentucky; before the end of the nineteenth century the leadership had shifted to North Dakota. During these fifty years Indiana, Illinois, Iowa, and Minnesota successively have been first in the production of this crop.

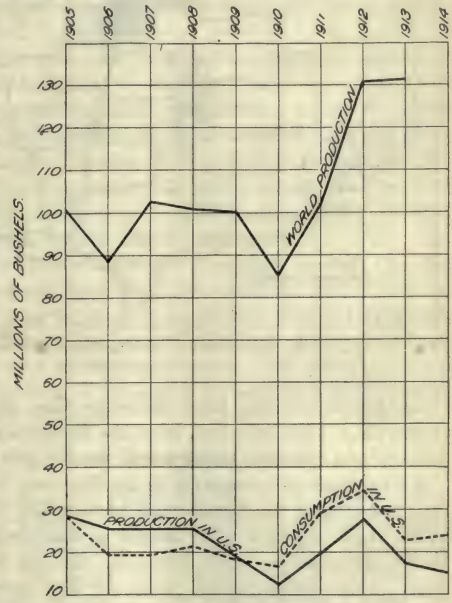

FIG. 1.—Diagram showing the world production of flaxseed, 1905 to 1913, and the production and consumption of flaxseed in the United States, 1905 to 1914, inclusive.

The annual production and consumption of flax in the United States and the annual world production from 1905 to 1914, inclusive, are shown graphically in figure 1. This diagram shows that until

1909 this country exported flaxseed. Since that time the flaxseed crushers of the United States have had to import seed to supply their demand. Until 1914 they depended largely on Canadian-grown seed. In 1915, owing to an adverse season and a small acreage of flax in Canada, the supply from this source was not sufficient for their needs. It was therefore necessary to import seed from other countries. Because of conditions arising from the European war it was possible to obtain seed from Argentina which up to that time had been shipped to England and to continental Europe. Though seed was available at low prices, abnormally high ocean freight rates helped to maintain the price of home-grown seed at a high level. Good prices for flax have therefore been obtained in the United States since 1912, in which year the production in the United States and Canada exceeded the demand, resulting in low prices.

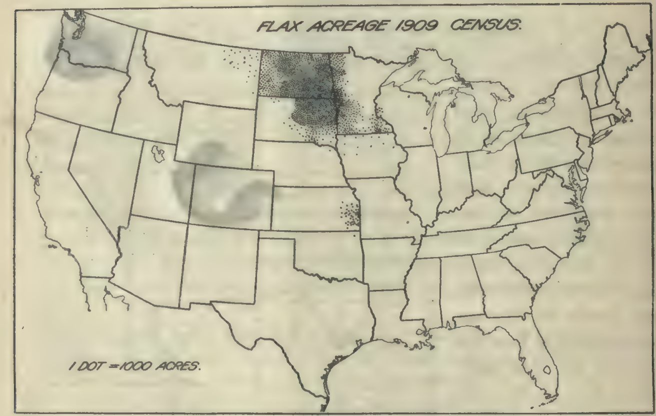

FIG. 2.—Map of the United States, showing the flax acreage according to the census of 1909.

An epidemic of wheat rust in the Northern States in 1916 has again impressed upon the farmer the advisability of crop diversification. With wheat almost a total failure in many sections there is likely to be less dependence in the future on this one cash crop. Though the wheat crop failed, good yields of flax generally were obtained. These good yields and the relatively high price since 1912 have caused the growing of this crop to be looked on with more favor in sections where it can be produced successfully. With the knowledge now available with regard to the advisability of growing flax in rotations of several years' duration and the value of grading, cleaning, seed treatment, and the proper preparation of the land, the flax crop should take a more prominent place in the permanent agriculture of the North-Central States.

THE FLAX-GROWING AREA.

Figure 2 shows the area devoted to flaxseed production in the United States in 1909. Since that time the center of production has moved farther west. Flax is now most largely grown in Minnesota, the Dakotas, and Montana. Some flax also is produced in Wisconsin, Iowa, eastern Kansas, and the more favorable dry-land areas of Nebraska, Colorado, and Wyoming. It is grown to a limited extent in Idaho, Washington, and Oregon, in which States the acreage will doubtless be increased when better railroad and marketing facilities are furnished. Where proper methods of rotation are practiced it is a profitable crop on old lands. As a cash crop under irrigation in the Northwest it gives much promise in rotation with sugar beets, alfalfa, and corn.

Flax is grown under a wide variety of soil and climatic conditions. West of the Red River valley in North Dakota and in central South Dakota the average annual rainfall ranges from 15 to 20 inches. Here the crop is largely dependent on the rainfall during the growing season. Rapid climatic changes and periods of drought are frequent. Under these conditions flax with short, coarse straw and uneven fiber is produced. As the crop is of little or no value for fiber, the highest yielding seed strains should be grown.

Where the rainfall is more abundant it is possible in some localities to grow flax producing excellent fiber for spinning, and over wider areas with a rainfall of only 25 to 30 inches flax with a fair quality of fiber not suitable for spinning but for other industries which heretofore have used imported flax tow and waste. The growing of flax for fiber and the utilization of the straw of seed flax have recently been discussed in other bulletins.[1]

VALUE OF THE CROP.

Flax has found such favor as a sod crop that its center of production is always near the frontier. With the development of the States in the northern Great Plains area the increase in flax acreage and production for a time was rapid. The supply was larger than the home demand, and prices were not always maintained at a point high enough to enable farmers to grow this crop with profit where land values were comparatively high. For this reason and because disease has reduced the yield in some sections, flax has not found a permanent place in the agriculture of the older States.

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[1] Miles, F. C. Fiber flax. U. S. Dept. Agr., Farmers' Bul. 669, 19 p., 10 fig. 1915.

Merrill, J. L. Utilization of American flax straw in the paper and fiber-board industry. U. S. Dept. Agr. Bul. 322, 24 p., 8 fig. 1916.

If properly handled, flax can be grown with profit in all of the Northeastern and North-Central States, as well as in the area where it is now being produced. Conditions may change so that it will be grown again in this area. At the present time, however, there are few markets east of Minneapolis and Duluth where flax can be sold in less than carload lots, and none at all east of Chicago. Farmers who live east of these cities, therefore, should not grow small acreages. If a large enough acreage is sown to produce seed in carload lots for shipment to wholesale markets at Chicago or Buffalo, the crop can be grown to advantage throughout most of this region. The southern limits of profitable flaxseed production have not been determined. The crop has never been grown commercially for seed south of Kentucky, and in Missouri and Kansas it has not given as good results as in the States farther north.

Table I, compiled by the Bureau of Crop Estimates of the United States Department of Agriculture, compares the acre value of flax, wheat, oats, and barley for the 10-year period 1906 to 1915, inclusive. These figures show that the acre value of flax was the highest of any of these crops in the States of North Dakota, South Dakota, Minnesota, and Wisconsin; second in Nebraska; third in Iowa and Kansas; and fourth in Montana and Missouri. Its poor showing in Montana no doubt results from the fact that flax usually is grown on dry land, while a considerable part of the other crops is produced under irrigation. This is an unfair comparison. In reality, flax is a promising cash crop for the more favorable dry-land portions of this State as well as for the irrigated lands.

TABLE I.—*Farm value of flax per acre in nine States, based on the average annual yields and average farm price per bushel on December 1 of the ten years 1906 to 1915, inclusive, compared with the acre values of wheat, oats, and barley in the same years.*

State.	Flax.	Wheat.	Oats.	Barley.	State.	Flax.	Wheat.	Oats.	Barley.
North Dakota	$12	$10	$9	$10	Iowa	$14	$15	$11	$15
South Dakota	12	10	9	11	Missouri	9	13	10	15
Minnesota	14	12	11	13	Nebraska	12	14	9	10
Montana	14	20	18	19	Kansas	9	12	10	9
Wisconsin	19	16	13	18					

FLAXSEED MARKETS.

The two principal primary flaxseed markets of the United States are Minneapolis and Duluth, Minn. More flaxseed is crushed in Minneapolis and St. Paul than in any other locality in the United States. Seed sent to the Duluth market is cleaned and reshipped to

Chicago, Cleveland, Toledo, Buffalo, New York, and Philadelphia, where other important linseed-oil mills are located. Numerous mills in other cities at various times have been more or less favorably located with regard to the flax-producing areas. These now obtain most of their seed from the two principal flaxseed markets. A small mill at Portland, Oreg., obtains most of its supply from the Orient. Growers in western Montana, Idaho, and other Western States can ship to Portland more economically than to the Minnesota markets.

VARIETIES OF SEED FLAX.

Flax grown commercially in the United States may be divided into three main crops: (1) Seed flax, (2) short fiber flax, and (3) textile fiber flax.

The textile fiber flaxes are not grown for seed, although the seed is a by-product when they are grown for fiber. Small admixtures of this type are usually found in fields grown from commercial seed. This is the only group producing fiber suitable for spinning.

In the short fiber group are to be found such strains as Primost (Minnesota No. 25) and North Dakota Resistant No. 114, distributed by the Minnesota and North Dakota Agricultural Experiment Stations, respectively. Commercial seed in some areas is made up largely of this type, and it is almost always found to some extent in fields of common flax. These short fiber flaxes have more slender stems than flax of the seed type. They have fewer basal branches and a more compact panicle (head), nearly level on top. This type is earlier than the seed flax.

The seed flaxes have a longer period of blooming than the short fiber flaxes. The panicles have many branches and are uneven at the top. To this type belong North Dakota Resistant Nos. 52 and 73, the so-called Russian flax (North Dakota No. 155), and the selections from the latter strain distributed by the North Dakota Agricultural Experiment Station, as well as several importations from Russia grown experimentally in the Northwest. Most of the commercial flax varieties are true seed flaxes but contain mixtures of the short fiber flax. The large-bolled, large-seeded flaxes, which are numerous in occasional fields, doubtless had their origin in commercial importations of seed from Argentina. Except in size of bolls and seeds these closely resemble the Russian seed flax.

In cool, cloudy weather the seed flaxes continue to bloom for a long time and may have open flowers and green and ripe bolls on the same panicle. The short fiber type has a more definite growth period, but may make a second growth if wet weather comes about the time the crop matures.

Varietal tests at 10 stations in the northern Great Plains area for periods of three to six years show that the seed-flax varieties give uniformly better results than the short fiber flaxes. In nearly every test North Dakota No. 155 or some selection from it has given the highest yield, while North Dakota Resistant Nos. 52 and 73 and two or three similar strains have been among the best varieties. These stations are all located west of the Red River valley in sections where flax wilt is not serious.

In the subhumid sections farther east, North Dakota Resistant No. 114 and Primost (Minnesota No. 25) have been widely distributed. They are quite similar in appearance. North Dakota Resistant No. 114 is probably the most resistant strain to both wilt and rust that can now be obtained. The yields of these two varieties of short fiber flax and of commercial mixtures containing a majority of plants closely resembling them have not been satisfactory at the 10 stations in the semiarid sections.

Figures 3 and 4 show the varietal test plats at Mandan, N. Dak., in 1914 and at Moccasin, Mont., in 1915. These give an idea of the nature and extent of the tests. The varieties shown here are sown in duplicate in twentieth-acre plats or in fiftieth-acre plats replicated five times. By means of such replications variations in the soil are detected and no variety has an unfair advantage in the test.

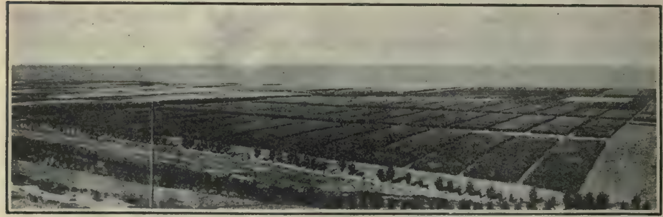

FIG. 3.—Panorama of flax experimental plats at the Northern Great Plains Field Station, Mandan, N. Dak., in 1914.

GOOD SEED.

WHERE TO GET SEED.

Where seed must be purchased, try to obtain it from some one in the locality who is known to have a good-yielding strain of flax free from weeds and disease. If no such seed is available, write to the State agricultural experiment station or to the Bureau of Plant Industry of the United States Department of Agriculture. If these agencies can not supply pure seed, they can probably tell where it can be obtained.

After a good strain of flax has been secured, it should be kept pure and free from weed seeds. Select a portion of the field that is free from disease and pull out all weeds the seed of which can not be separated from flax by the fanning mill. In this way seed flax is obtained that is (1) grown in and adapted to the locality, (2) free from admixture with weed seed that will infest the field and reduce the yield of flax, and (3) relatively free from disease which, if introduced into the soil, may become a serious menace to the flax crop.

Better seed can often be obtained by using a good, clean field for the production of seed flax. This field can be sown earlier than the larger fields, thus insuring the full development of the plants and the production of good, plump seed. If sown in rows 12 to 18 inches apart a man can walk through the field and pull the weeds without injury to the flax. Figure 5 illustrates a field seeded in this way.

FIG. 4.—Flax varieties growing in field plats at the Judith Basin substation, Moccasin, Mont., in 1915. (From a photograph lent by the Office of Exhibits, U. S. Department of Agriculture.)

CLEANING THE SEED.

Seed obtained from any source should be thoroughly cleaned with the fanning mill before sowing. A fanning mill which separates the light from the heavy seed by gravity is the most desirable kind to use. Wilt diseases live over in the chaff and immature seed and develop in the soil if such seeds are sown. Only the largest, plumpest seeds should be sown.

TREATMENT FOR WILT.

To insure further against the introduction of wilt with the seed, the formaldehyde treatment has been recommended by the North

Dakota Agricultural Experiment Station.[1] The seed is disinfected with a solution composed of 1 pound of commercial formaldehyde of standard strength (37 per cent) to 40 gallons of water.

Too much water should not be applied to the seed in this treatment. The mucilaginous seed coat swells rapidly and becomes sticky when damp. Use care in applying the solution or the seed will cake together in large lumps. Care should also be taken not to make the solution too strong, as there is danger of killing the seed.

The seed should be spread on a floor or tarpaulin already disinfected. The solution should then be applied in a fine spray with a force pump. If a force pump is not available, any convenient method by which the moisture may be applied evenly and in not too great quantity may be used. The seed should be stirred constantly while being sprayed, in order that the moisture may come in contact with all of it and still make no portion damp enough to cake. A half gallon of water is sufficient for each bushel of seed. After treatment, the seed may be left in a pile and covered with canvas or sacks which have been treated.

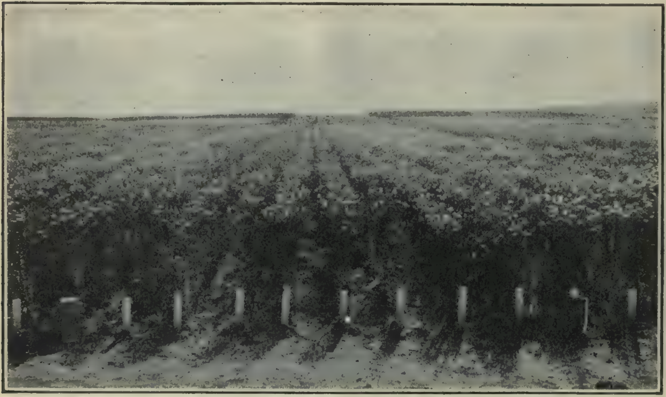

FIG. 5.—Flax selections growing in 8-rod rows 12 inches apart at the Northern Great Plains Field Station, Mandan, N. Dak., in 1915. Each row has been increased from a single plant selected in 1913.

Sometimes the seed is treated in a wagon box or a box light enough to be carried about in the field. It is then drilled immediately after treating, before it has any chance to cake.

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[1] Bolley, H. L., and Wilson, M. L. Cropping to flax on new lands of semiarid land areas. N. Dak. Agr. Exp. Sta. Bul. 103, 57 p., 27 fig. 1913. Also published as Mont. Agr. Exp. Sta. Circ. 22. 1913.

ROTATIONS FOR FLAX.

Up to the present time the bulk of the flax crop has been raised on breaking. Because of the high value of the seed per pound as compared with other grain, it makes an excellent crop for the homesteader who must haul his grain a long distance to market. Flax seems to be better adapted than any other crop to rotting prairie sod in preparation for succeeding crops. It has the further advantage of being a quick-growing crop. In the Dakotas and Montana the homesteader can continue breaking his land until the second week in June and still sow it to flax with fair assurance of a crop sufficiently large to pay at least for the breaking.

Where flax is sown on old land it should be grown in rotation with other crops. This is particularly necessary because of diseases which develop in the soil when the crop is grown continuously on the same land. These diseases often are introduced with the seed. In some sections they increase to such an extent that flax can not be grown, while in others they appear to have little effect. Trouble from flax diseases can be avoided largely if the flax crop is handled properly and is grown in a rotation which includes a cultivated crop. Where flax wilt is known to be present, flax should not be grown on the same field more than once in every five or six years, unless resistant varieties are used. Good farmers no longer grow the same crop continuously on a field if it can be avoided. Each farmer must work out the rotation which will most nearly meet his needs. For this reason no attempt to outline definite rotations is made in this bulletin.

Flax grown as the cash crop in a rotation should follow the cultivated crop or summer fallow if these are kept free from weeds. When such crops or fallow are cultivated properly and the weeds are destroyed, moisture is conserved. By seeding time the land is usually filled with water to a good depth. Flax is a shallow feeder. It will do well under favorable conditions of moisture and in a firm seed bed, while the water it uses will be largely replaced before the next crop is sown. In semiarid sections it can then be followed by one of the small-grain crops which take their water from greater depths. This crop will have the advantage of the winter and seasonal rainfall plus the moisture left in the subsoil by the flax the previous year. In this way flax is produced under the most favorable conditions and the water stored by the cultivated crop is saved and used to the best advantage.

Where Russian thistle, tumbleweed, wild oats, or pigeon grass are abundant, some small grain should precede the flax, as this crop is a poor weed fighter.

In the semihumid areas, where clover, alfalfa, or grass is included in the rotation, flax can often be used as the nurse crop. Its erect habit and small leaves do not shade the young grass and clover plants as much as other grains having a rank growth. If some other grain is used as the nurse crop, flax is often a good crop to sow when the sod land is broken. Weeds are not likely to be so troublesome when flax is grown at this period in the rotation.

Although flax is seldom seeded in mixtures with other grains, it sometimes volunteers in the succeeding crop if this is stubbled in on the old flax land. In areas where winter wheat is grown, if winter-killing has caused poor stands of the wheat, flax is sometimes sown on the land in the spring and the two crops are grown as a mixture. With reasonable care in thrashing and cleaning, both crops can be saved and marketed separately.

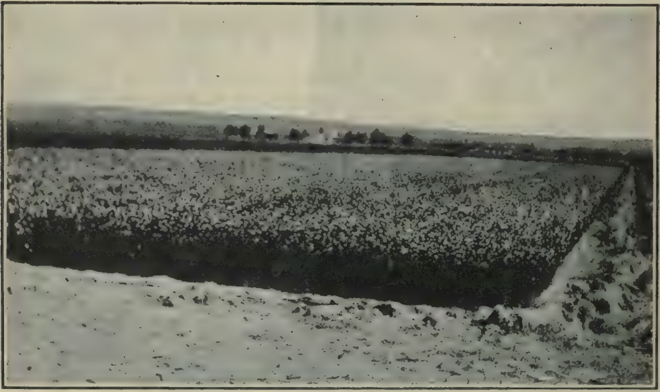

FIG. 6.—Flax on irrigated land on the Huntley Reclamation Project Experiment Farm in 1913. This plat yielded at the rate of 31.28 bushels per acre. (Photographed by Dan Hansen.)

On two of the irrigated experiment farms [1] of the Department of Agriculture flax has been grown continuously and in a 6-year rotation. No disease has been detected in these tests. On both farms the rotation consists of three years of alfalfa, followed by one year each of corn, flax, and sugar beets. The third-year alfalfa and the corn are hogged off. Four years' results have now been obtained in these tests. At Huntley, Mont., the average yield of flax in this rotation for the 4-year period is 25.8 bushels, the highest yield being 31.3 bushels. The average yield of the continuously cropped plats is 10.1 bushels; the highest yield, 14.5 bushels. The yield of this continuously cropped field has increased each year. Figure 6 shows the 1913 flax plat in the 6-year rotation here discussed. In addition to the favorable yields of flax in this rotation the sugar beets following the flax have been one of the highest-yielding beet crops in the rotation series.

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[1] Hansen, Dan. The work of the Huntley Reclamation Project Experiment Farm in 1914. U. S. Dept. Agr., West. Irrig. Agr. 2, 23 p., 8 fig. 1915.

Aune, Beyer. The work of the Belle Fourche Reclamation Project Experiment Farm in 1914. U. S. Dept. Agr., West. Irrig. Agr. 4, 16 p., 2 fig. 1915.

Similar results were obtained at the Belle Fourche station near Newell, S. Dak. In 1914 the flax plat in the 6-year rotation yielded 21.4 bushels, while the yield of the continuously cropped plat was 7.5 bushels. The average yield of all flax plats for three years is approximately 14 bushels.

A rotation similar to the above in the irrigated rotation series at the Scottsbluff Experiment Farm, Mitchell, Nebr., has not given as favorable results so far. Unfavorable weather conditions, however, have affected the experiment, and the test has not been conducted for a period long enough to warrant definite conclusions.

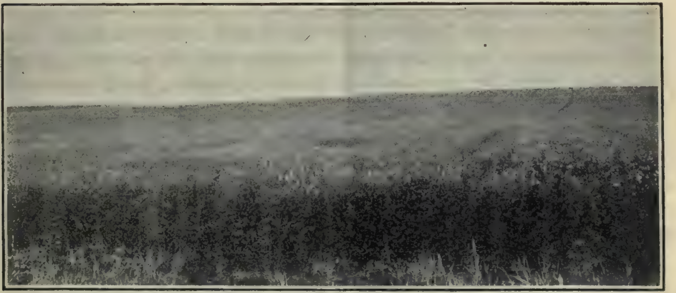

FIG. 7.—A 320-acre field of North Dakota Resistant No. 52 flax on breaking, 15 miles south of Mandan, N. Dak. The average yield of this field was 15.1 bushels per acre.

PREPARING THE SEED BED.

If sod is broken in the fall, the land should be well packed in the spring either by heavy rolling or by disking and harrowing, or both, and the surface made as smooth as possible. The planker (plank drag) is often used for leveling and packing sod land. Spring breaking should be packed and the seed bed prepared as soon as possible, in order that the seed may be sown before the upturned sod has become dry. Figure 7 shows a 320-acre field of flax sown in this manner. A strip of sod was plowed, put into shape, and seeded. Then another strip was prepared in the same way. A clean, thrifty field of flax was obtained. Where tractor outfits are used, plowing, disking, packing, and seeding often are done in one operation. Land preparation and cropping methods under semiarid conditions have been discussed and well illustrated in two joint publications of the North Dakota and Montana agricultural experiment stations.[1]

A firm, well-prepared seed bed is as essential for flax when it is grown in rotation after other crops as it is when it is grown on new breaking. For this reason, when flax is sown after corn, potatoes, or summer fallow on land which has been kept free from weeds, the land is not plowed. Such fields are disked and harrowed in the spring to prepare a good seed bed and are then seeded before the moist surface dries.

Where it is desired to sow flax on fields that have not been kept free from weeds the land should be plowed, or the disking delayed until the weed seed has had an opportunity to germinate. It is often better, however, to grow some other grain crop for one year before flax is sown.

Dry pasture or meadow lands usually should be broken in the fall. The breaking will catch and hold the snow, and the run-off will not be as great when the snow melts in the spring as it is from unplowed sod land.

Whether the fall or spring plowing of stubble land is best for flax varies with the conditions under which the crop is grown. In the drier areas spring plowing will usually give the best results.

Because of the fine stems, flax stubble can easily be put into good tilth for sowing another grain crop by disking. Good crops can be raised at considerably less cost if this method is followed. Flax stubble should be plowed, however, if the flax was grown on land not previously plowed.

When flax follows corn or other cultivated crops under irrigation the land is prepared by disking and harrowing, just as under dry-land conditions. If it follows a small grain, the land is usually plowed in the fall. It is generally in better shape to work in the fall and is left in better tilth. Ordinarily there is sufficient moisture in the soil, so that it is not necessary to irrigate in the spring to germinate the seed.

SOWING THE SEED.

METHOD OF SEEDING.

Flax is usually sown with an ordinary grain drill. The depth of seeding depends largely on the depth at which moisture is present, as it is desirable to sow the seed in moist soil. It should not be sown deeper than 1 inch if there is sufficient moisture for its germination at that depth.

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[1] Bolley, H. L., and Wilson, M. L. Cropping to flax on new lands of semiarid land areas. N. Dak. Agr. Exp. Sta. Bul. 103, 57 p., 27 fig. 1913. Also published as Mont. Agr. Exp. Sta. Circ. 22. 1913.

Bolley, H. L., and Wilson, M. L. Flax cropping, harvesting methods. N. Dak. Agr. Exp. Sta. Circ. 1, 32 p., 43 fig. 1914. Also published as Mont. Agr. Exp. Sta. Circ. 40. 1914.

TIME OF SEEDING.

When not grown on breaking, flax has usually been sown as a late catch crop in the Northwest. This practice is so common that many growers have come to believe that flax should not be sown until June 1 or later. Many who have their land prepared earlier delay seeding until about this time. Although good yields are often obtained from late-sown flax, the farmer who follows this practice runs the risk of losing his crop from damage by early frosts. Contrary to common belief, flax is not easily injured by frost when young. If a hard frost occurs when the plants are just coming up some will be injured; if it occurs after they are up no material damage will result.

Tests in the northern Great Plains area for three years show that flax sown the latter part of April or the first week in May usually gives the best results. When conditions are favorable good yields are obtained from flax seeded as late as the first week of June. The early-sown flax is ready to ripen during the period of hottest summer weather. Flax sown in June seldom comes into bloom until this period is nearly over. Seedings made from May 15 to June 1 often come into full bloom when moisture conditions are very unfavorable and the hot winds dry up the plants. Under such conditions the period of bloom is usually short and the yield consequently reduced.

In the high, dry plains at altitudes of more than 5,000 feet spring rains are infrequent and the soil becomes warm slowly. Under these conditions late seeding usually gives the highest yields.

At lower altitudes on the Great Plains seeding should be done early, as soon as the seed bed is prepared and before weed seeds have time to germinate. If this can not be done, the weed seeds should be allowed to germinate and the field disked before sowing. As it is not usually desirable to sow flax in the Dakotas and Montana during the latter half of May, this disking should be delayed until late in May, so that the flax can be sown about June 1 on freshly disked land. Flax sown as late as June 1, however, often has to be cut in damp, cloudy weather and while the straw is still green, making the harvesting difficult. Such flax cures slowly and autumn rains or snow usually occur before it can be thrashed. This often reduces both the yield and quality of the crop. But where adverse weather conditions delay seeding or late seeding otherwise seems desirable, flax is probably the money crop best adapted throughout the flax-producing area.

RATE OF SEEDING.

Where the annual rainfall is not more than 20 inches, flax need not be sown at a rate greater than 20 pounds to the acre. This should be reduced to 15 pounds under drier conditions. Where the rainfall is more than 20 inches a slightly higher yield may be obtained if 25 or

30 pounds are sown to the acre. The sowing of more than 30 pounds to the acre on dry land is of doubtful value.

Flax grown under irrigation is commonly sown at the rate of 35 to 45 pounds per acre. It is not known whether a lower rate would give as good returns.

Because of the heavy rate of seeding used where flax is grown for fiber many farmers who grow the crop for seed sow at a much higher rate than those just recommended. This high rate of seeding is unnecessary and, because of the high price of seed, is also unprofitable. Thick seeding with seed flax or short fiber flax, even in areas where fiber flax can be grown, does not produce textile fiber flax, but will probably reduce the yield of seed.

IRRIGATING THE CROP.

Comparatively little flax is grown in the United States on irrigated land. Where water is supplied, one or two irrigations during the period between emergence and full bloom will generally be sufficient. The crop will ripen more uniformly if no water is applied after it is in full bloom. Irrigations should be light. The water should be applied rapidly and as evenly as possible, so that no portion of the field may be covered for any length of time. Land not easily penetrated by water should be irrigated in the late afternoon or at night. If water remains on the field for several hours during the day the plants will be scalded. Such plants often form bolls and turn brown as though ripe, but these bolls contain little or no seed.

HARVESTING THE CROP.

CUTTING.

Flax should be fully ripe when cut. In normal seasons the stems dry and turn brown before the seed is thoroughly mature and the crop is almost cured at the time of harvest. When the season is late, cool, and wet, the stem often remains green and the plant continues to bloom till frost. Most of the bolls, however, will ripen before danger of frost makes cutting advisable. Fax cut when the stems are green requires a longer time to cure than flax with ripe straw.

On smooth land most flax can be cut and bound with a binder. By the proper adjustment of the reel and butter, bundles of fair size and shape, such as are shown in figure 8, can be made. When these are shocked the seed is kept from the damp earth. The crop dries more readily after rain and snow, and diseases do not develop as rapidly as if the flax lay flat on the ground. This is probably the most satisfactory method of harvesting flax on a small farm. The principal objection to bound flax is that if the bundles are damp when thrashed they mat together and choke the machine. This is especially likely to happen if some of the bands are not cut. The irregular shape of the bundles makes band cutting difficult.

On large farms headers are often used with satisfactory results, the heads being stacked in long, low ricks. The plants must be ripe when headed or the flax will heat and reduce the quality of the seed. The combined harvester and thrasher also may be used, though this is difficult to regulate so the flax can be thrashed to advantage.

Some growers remove the binder attachment from the grain binder, attach a buncher, and drop the flax bunches in a windrow. Sometimes the binder attachment is removed but no buncher is used. The flax is then bunched with the bundle carrier or it is allowed to fall in a continuous windrow. These methods are not satisfactory. Reapers and mowers with bunching attachments also are utilized. All of these methods leave the flax panicles and bolls on the ground, where they readily become damp. Under these conditions fungous diseases multiply easily. This increases the disease in the soil and on the seed and straw and reduces the grade of the flax. For these reasons, every effort should be made to keep the flax crop as dry as possible before thrashing.

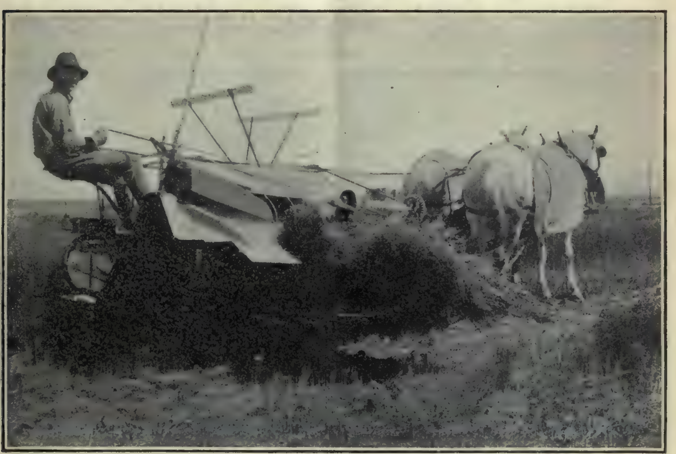

FIG. 8.—Cutting flax with a binder. By a proper adjustment of the machine most flax can be bound with little difficulty.

SHOCKING OR STACKING.

If the flax is bound it should be shocked in long shocks only two bundles in width, such as are shown on the title page. The bundles are very compact and will not dry readily after rain if wider shocks are made. Where the flax is not bound, at least that intended for seed should be thrown into small stacks and covered with hay, straw, or tarpaulin as a protection from rain.

THRASHING.

Flax is usually the last crop thrashed on the farm, as it is often not ready when the other thrashing is done. Because the separator must be specially adjusted for flax, thrashermen usually prefer to thrash all other grain before beginning on the flax crop. Flax, therefore, is often subjected to much bad weather. If it has been shocked and stacked or otherwise protected from the fall rains, the bolls will be dry and in good condition. If the heads are damp, the seed is not easily beaten from the bolls and a considerable portion of it goes over with the straw.

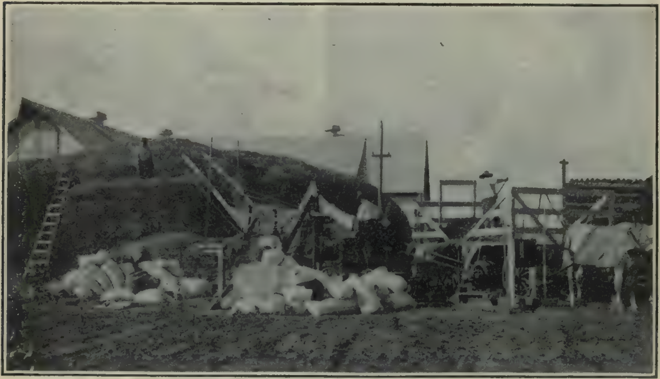

FIG. 9.—Thrashing flax at the Northern Great Plains Field Station, Mandan, N. Dak., in 1914. This machine is thoroughly cleaned after each variety is thrashed.

Where a portion of the flax field has been carefully saved for seed, the thrashing machine should be thoroughly cleaned before the crop from this portion is thrashed. This is particularly necessary if the separator has been used in thrashing diseased or weedy flax. All seed should be removed from the top of the concave plates, from the return spouts, grain elevators, beaters, and screens and from beneath the cylinder. If the quantity to be thrashed is small, the grain elevator should be removed, especially if small quantities of two or more varieties are being thrashed. After the machine has been cleaned thoroughly, it should be run empty with the wind blast turned on full to blow and shake out any seeds that have lodged in inaccessible places. Figure 9 shows a small thrasher used in thrashing varietal plats of flax. The grain elevator is not used, and between the thrashing of two varieties the machine is cleaned in the manner indicated.

Many thrashers try to clean the flax too well as they thrash it. This usually results in blowing much good seed over with the tailings. This, together with what goes over with the straw unthrashed, often decreases the yield materially. In order to obtain all the seed it is necessary to admit some dirt. The farmer is not given a poorer grade for the dirty seed. He is docked for the actual amount of dirt in the seed, and the grade and price are determined from the cleaned sample. If growers were generally aware of this fact there would be less seed fed or burned with the straw.

STORING THE SEED.

Where flax is stored for seed it should first be cleaned. Only the plump, sound, dry seed should be saved. This will reduce the danger of heating and also the development of disease from the chaff and immature seed, upon which the disease spores are readily carried.

PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE RELATING TO FLAX PRODUCTION.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Cereal Experiments at the Williston Substation. Department Bulletin 270.

Cereal Investigations on the Belle Fourche Experiment Farm. Department Bulletin 297.

Utilization of American Flax Straw in the Paper and Fiber-Board Industry. Department Bulletin 322.

Cereal Experiments at the Judith Basin Substation, Moccasin, Mont. Department Bulletin 398.

Cereal Experiments on the Cheyenne Experiment Farm, Archer, Wyo. Department Bulletin 430.

Fiber Flax. Farmers' Bulletin 669.

Grains for the Montana Dry Lands. Farmers' Bulletin 749.

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FALL-SOWN GRAINS IN MARYLAND AND VIRGINIA

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FARMERS' BULLETIN 786

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

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FOR THE BEST RESULTS, fall-sown grains in Maryland, Delaware, and the Virginias require—

A well-drained, fertile soil, well supplied with humus and lime.

An abundance of available plant food, supplied by the use of stable manure, green crops turned under, and commercial fertilizers.

A rotation which includes at least one cultivated crop and one or more legumes.

A seed bed with the surface 2 or 3 inches loose and finely pulverized, while the soil just beneath is firm and moist.

Good, pure, cleaned, and graded seed which has been treated for smut, sown with a drill at the proper time and rate.

Varieties which are adapted to the locality and which produce high yields of grain of good quality. The best varieties are listed on page 23.

FALL-SOWN GRAINS IN MARYLAND AND VIRGINIA.

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INTRODUCTION.

Methods and practices relative to the growing of fall-sown grains in Maryland and Virginia are discussed in this bulletin. While the statements made are based largely on experiments conducted in these two States, they are applicable over a somewhat wider area. The four States to which they particularly apply are Delaware, Maryland, Virginia, and West Virginia, constituting the northern portion of the South Atlantic group of States. Recommendations are also made as to the best varieties of the various grains to grow.

With the exception of wheat, the small grains are not important crops in these States. The average acreages of wheat, oats, barley, and rye in each State for the five years from 1911 to 1915, inclusive, with the acreage of corn for the same period for comparison, are shown in Table I.

TABLE I.—*Average acreage of corn, wheat, oats, barley, and rye in Delaware, Maryland, Virginia, and West Virginia for the five years, 1911 to 1915, inclusive.*

State.	Corn.	Wheat.	Oats.	Barley.	Rye.
Delaware	198,800	115,200	4,000	....	1,000
Maryland	676,600	612,800	44,800	4,600	26,200
Virginia	1,997,200	856,800	196,000	10,800	56,400
West Virginia	739,200	248,400	112,200	....	16,800

As shown by Table I, wheat is an important crop in each of the four States, though in every case the acreage is smaller than that of corn. The average wheat acreage in Delaware for the five years from 1911 to 1915, inclusive, is about one-sixth (16.1 per cent) of the improved farm land in the State as recorded in the census of 1910. In Marland it is 18.3 per cent of the acreage of improved farm land, being only slightly smaller than the corn acreage. In Virginia only about 1 acre of improved land in 12 is sown to wheat, the percentage being 8.7, while in West Virginia only 4.5 per cent of the improved farm land is devoted to this crop.

None of the other grain crops occupies more than 2 per cent of the improved farm land in these States, oats just reaching that figure in Virginia and West Virginia. Rye does not occupy 1 per cent of the improved acreage in any of the four States. It is of greatest importance in Maryland (0.8 per cent) and Virginia (0.6 per cent). These figures represent the acreage harvested for grain. The acreage of rye sown is no doubt considerably greater, as many acres are plowed under for green manure each year.

GENERAL PHYSICAL CONDITIONS.

The three great natural divisions of the South Atlantic States are the Appalachian Mountains on the west, the Atlantic Coastal Plain on the east, and the Piedmont Plateau between. The elevation in these States varies from sea level to more than 3,000 feet. Climatic and soil conditions in the three sections are also markedly different. As a result, varieties and methods of culture of the different grain crops well adapted to one section are not always the best for another.

Rainfall in this section of the United States is usually ample for crop needs without special methods of moisture conservation such as are commonly practiced in regions of limited rainfall. Destructive winds and hailstorms very rarely occur, and comparatively mild winters usually prevail. In the vicinity of Washington, D. C., the lowest winter temperature usually ranges from zero to 10° F., falling as low as zero only about once in three years. In the higher western portions of Maryland and Virginia and in West Virginia the winters are much colder, zero temperatures occurring nearly every year. Only the hardier fall-sown grains, winter wheat and rye, survive there with certainty, though winter oats and winter barley can be grown successfully in favorable locations if sown early.

SOILS.

Many different types of soil are to be found in the South Atlantic States, varying from the lightest sands to the heaviest clays.

Loam soils are the most suitable for the production of grain; hence the clay loams of the Piedmont section and the sandy loams in the higher portions of the Coastal Plain are well adapted to this purpose. The heavier clay and silt loams in the valleys west of the Blue Ridge, especially those of limestone origin, are among the best wheat soils in the United States. The best example of this type is the Hagerstown loam, a silt loam overlying a clay subsoil.

The typical soils of the Coastal Plain area are lighter and more sandy, including such well-known types as the Leonardtown loam and the Sassafras sandy loam. These soils when well supplied with lime and vegetable matter in connection with proper fertilization and a good system of crop rotation will produce profitable crops of winter wheat and other fall-sown grains. Winter oats are well adapted to these more sandy soil types and should be more generally grown than they are at present.

Fall-sown grains require a well-drained soil. In those sections in which the land is not naturally well drained, tile or other drainage should be supplied, as thorough surface and subsoil drainage is one of the first essentials for the production of profitable yields. Poor soil drainage is more often the cause of winterkilling and consequent failure of winter grain crops than any other soil condition.

FERTILIZERS.

Practically all the soils of the eastern United States which have been tilled for many years are deficient in the more important elements of plant food. Phosphorus, nitrogen, and in some localities potassium (potash) must be supplied in order to obtain satisfactory yields of grains and other field crops. These are in addition to liberal supplies of lime and humus, or decayed organic matter.

In those sections where the soil is in a good state of fertility, because a good system of crop rotation has been followed or because live stock has been included in the scheme of farming, phosphorus is usually the element that is most needed. It may be supplied by the addition of some form of phosphatic fertilizer, such as acid phosphate, ground rock phosphate (floats), steamed bone meal, or basic slag. Rock phosphate should be used only in combination with stable manure or green manure.

The principal sources of nitrogen are manure, the nitrate fertilizers, and the air. Of the nitrate fertilizers the most common are nitrate of soda, ammonium sulphate, cottonseed meal, tankage, and dried blood. The greatest and cheapest source of nitrogen is the air, for by growing such leguminous crops as clovers, cowpeas, soy beans, and vetch in rotation or as catch crops, nitrogen from the air is added to the soil much more economically than by the use of mineral fertilizers.

Soil analysis shows that most soils contain sufficient quantities of potassium (potash), but often it is not in a form available to plants. This condition usually can be corrected by the generous use of barnyard manure or green manure. The decay of this material in the soil ordinarily makes sufficient quantities of potash available for crop needs. Where barnyard manure is not produced in sufficient quantities, or the plowing under of green manure is not practicable, potassium must be supplied in the form of commercial fertilizers. Those most commonly used are sulphate of potash, muriate of potash, and kainit.

Calcium or lime is supplied in either the burnt (calcium oxid), the slaked (calcium hydroxid, or hydrated lime), or the raw form (calcium carbonate), to improve the physical and chemical condition of the soil. Its chief function is to correct soil acidity, to "sweeten the soil," making it more suitable for the various soil organisms which aid plant growth. Only a small percentage of lime is actually taken up by cereal plants. Humus, or decayed organic matter, is supplied in barnyard manure or green manure and in crop residues (stubble, second growth, weeds, etc.).

The best results with small grains are usually obtained if the barnyard manure is applied to a preceding cultivated crop, such as corn or potatoes. When applied to the grain crop directly, the excess of nitrogen in the manure is likely to produce a heavy growth of straw, which may lodge. If the manure is applied to the small-grain crop it should be supplemented by 200 to 250 pounds of acid phosphate or rock phosphate (floats). This is also good practice when a heavy growth of cowpeas or other green crop is plowed under immediately preceding the grain crop.

A complete fertilizer usually gives the best results on thin soils, especially where little or no barnyard manure or green manure is available. If wheat follows oats or some other small-grain crop on land of fair to medium fertility, it will usually pay to use some nitrogen and potassium in the fertilizer. A 3–10–3 fertilizer—that is, one which contains 3 pounds of nitrogen for each 10 pounds of phosphorus and 3 of potassium—gives a very good proportion if a sufficient quantity is applied. On the worn soils of southern Maryland and east of the Blue Ridge in Virginia from 350 to 450 pounds of this fertilizer to the acre should give fair results. On the more fertile soils, especially those lying immediately to the west of the Blue Ridge in Maryland and Virginia, 150 to 250 pounds to the acre are sufficient.

If additional nitrogen is used, it should be applied as a top-dressing at about the time growth starts in the spring. For the spring application 75 to 125 pounds of nitrate of soda to the acre are most commonly used. Experiments conducted by several of the experiment stations in the eastern United States indicate that top-dressing the small grains is usually profitable only when the crop is in a backward condition, as the result of poor land, late seeding, abnormal weather conditions, etc. If the crop is well supplied with plant food, the use of nitrate of soda in this manner is of doubtful value. No nitrogen is needed if leguminous green-manure crops, such as crimson clover or vetch, are grown in the rotation.

Half a ton to a ton of burnt lime or from 1 to 2 tons of ground or crushed limestone to the acre is a sufficient quantity to apply to most soils needing lime in the section under discussion. Heavier applications may be made, but it is usually considered better practice to make frequent light applications. There is then less loss through seepage and leaching. Two tons of ground limestone every four years is usually a satisfactory rate.

ROTATIONS.

In those sections of the South Atlantic States in which general farming is practiced one or more of the fall-sown grain crops usually occupy an important place in the rotation. In addition to their value as grain crops they serve as nurse crops for clover and grass, as winter cover crops, and frequently as winter pasture crops.

The continuous cropping of land to wheat or any other small-grain crop results in reduced yields and a depleted soil. A rotation of grain crops is not advisable, as it is little better than continuous cropping. By using large quantities of chemical (commercial) fertilizers it is possible to grow grain crops continuously on the same land for a long period of years, but the cost of the fertilizers makes such a practice unprofitable.

A good rotation should include a cultivated crop as well as a legume. The frequent stirring of the soil renders it loose and friable, improving its physical and chemical condition and making it more congenial to plant growth. In addition to this beneficial effect, the cultivation of row crops tends to destroy weeds and aids in keeping the land free from these pests.

The legumes not only gather nitrogen from the atmosphere and store it in the soil in a form available to succeeding crops, but also aid in maintaining the supply of humus. The clovers, cowpeas, and soy beans are the principal legume crops included in rotations with winter grains.

As a rule, local conditions determine the particular crops to be grown and their order in the rotation. For the greater portion of the Piedmont area and for many of the broad valleys west of the Blue Ridge a 4-year rotation of corn, wheat, and two years of clover and timothy or a 5-year rotation of corn, wheat two years, and clover and timothy two years, is the most practicable. By growing wheat twice in succession, as indicated in the second of these rotations, better conditions can be obtained for sowing to grass and clover. Meadows which result from "sowing down" with wheat on disked corn-stubble land are often rough and uneven, making the use of modern haying machinery more or less difficult. The timothy should be sown with the wheat in the fall and the clover sown early in the following spring. In some districts of the lower Piedmont section fall-sown oats or barley may be added to the rotation with profit.

For Delaware, eastern and southern Maryland, and practically all of the upper Coastal Plain section of Virginia, similar rotations are adapted. Here crimson clover, cowpeas, and soy beans grow well, and one or more of these crops should be included in the rotation either for hay or for green manure. A 5-year rotation of corn, corn, wheat, winter oats, and clover is practicable. In this rotation crimson clover should be sown in the first crop of corn at the last cultivation and plowed under the following spring for the second crop of corn. It is also possible to grow a crop of cowpeas or soy beans for hay or green manure between the two small-grain crops.

A rotation that should be well adapted to these sections is as follows: (1) Corn, followed by rye, vetch, crimson clover, or rye and vetch, to be cut for hay or plowed under the following spring for green manure; (2) cowpeas or soy beans for hay; (3) wheat or fall-sown oats; (4) clover. This rotation provides for a cover crop each year, a crop that may be removed from the land each year, one green-manure crop, and two legumes. By supplementing these soil-improvement crops with generous applications of raw or rock phosphate in connection with the proper use of lime and the manure that is available on the average farm, such a rotation system should prove practicable, while at the same time it will maintain and gradually increase the fertility of the soil. This rotation is suitable also for some of the lower districts of the Piedmont area, particularly those in which straight grain farming has been generally practiced.

Other rotations, including one or more of such crops as potatoes, tobacco, rye, alfalfa, etc., in addition to any of the crops already mentioned, may be devised along similar lines.

PREPARATION OF THE SEED BED.

The ideal seed bed for fall-sown grains is one in which the surface soil to a depth of 2 or 3 inches is loose and finely pulverized, while the subsoil is firm and moist. To obtain these conditions the land should be plowed to a depth of 6 to 8 inches as early in the season as possible. For the best results the harrow should follow the plow immediately. Harrowing should be repeated frequently to kill weeds, to aerate the soil, and to settle the seed bed, especially the lower portion of the furrow slice. Late plowing does not allow the soil to become sufficiently compact for the best results.

In those sections in which the winter grain crop follows corn, the best seed bed usually can be prepared by disking and harrowing rather than by plowing. If weeds are numerous, plowing may be desirable. As plowing must be delayed, however, till the corn is mature, there is usually not sufficient time for the seed bed to become well settled before sowing. For this reason, the land should not be plowed unless the weeds are so large and numerous that the disk harrow can not be used effectively.

When a heavy growth of cowpeas or other green-manure crop is plowed under, preceding winter grains, the plowing should be done at least two or three weeks before seeding time, in order to allow the vegetable matter plowed under to begin to decay and to become mixed with the soil. When these crops have been removed for hay a good seed bed usually can be prepared by disking and harrowing.

A well-prepared seed bed always greatly increases the chances of success in growing fall-sown grains. The importance of a good seed bed can not be too strongly emphasized. Thorough tillage in its preparation helps in offsetting the effects of drought and other unfavorable conditions.

THE SEED.

Experiments show that home-grown seed gives better returns than that brought from a distance. Changing seed is not to be encouraged if the variety grown is pure and is adapted to the locality.

All seed grain should be fanned and graded to remove weed seeds, chaff, straw, smut balls, and small or broken grains. This can be done with an ordinary fanning mill if it is properly adjusted.

Stinking smut of wheat, smut of oats, and covered smut of barley can be controlled by the formaldehyde treatment. Commercial formaldehyde (about 37 to 40 per cent pure formaldehyde) may be obtained at almost any drug store. To apply this treatment, mix the formaldehyde with water at the rate of 1 pound (slightly less than a pint) to 40 gallons of water. Spread the grain on a clean floor or canvas and sprinkle with the solution, shoveling the pile over during the process so that the surface of every grain is thoroughly wet. About a gallon of the solution will be needed for each bushel of dry grain. Immediately after sprinkling, shovel the grain into a pile, cover it with sacks wet with the solution, and allow it to stand for at least two hours before spreading it out to dry.

Instead of sprinkling the grain, it may be inclosed loosely in bags and immersed in a tub of the solution, or the loose grain may be put directly into it. The grain should be left in the solution only long enough to make sure that all of it has been wet. When loose grain is put into the solution the effectiveness of the treatment is increased by skimming off the smut balls that come to the surface.

The treated grain may be sown as soon as it is sufficiently dry to run through the drill. If the seed is still moist, however, the drill must be set to sow a greater quantity to the acre than if it is dry. The treated seed should not be allowed to come in contact with bags, bins, or machinery in which there may be smut spores. To avoid this danger, drills, bags, etc., should be washed with the formaldehyde solution before putting the treated grain into them.

For the loose smut of wheat and barley, the hot-water treatment is the only effective preventive yet known. This treatment must be used with great care or the germination of the seed will be destroyed. For particulars regarding it and also for fuller details of the formaldehyde treatment, see Farmers' Bulletin 507.[1]

The germination of wheat, oats, and barley is usually good. Rye quickly loses its germinating power, and seed of this grain more than a year old should not be used unless a test shows that it will germinate. Germination tests may be made at home, or samples may be sent for this purpose to the Seed Laboratory of the appropriate State experiment station or of the United States Department of Agriculture.

SOWING THE SEED.

TIME OF SOWING.

Winter grains should be sown early enough to allow the plants to become well started before continued freezing weather begins. However, they should not be sown so early as to allow them to start jointing in the fall. In those sections in which the Hessian fly is troublesome, the sowing of wheat should be delayed until about the time the Hessian fly ceases to lay eggs. If the young wheat plants come up before that time, eggs are deposited on them and the crop later is injured by the insects which develop from these eggs. In Frederick County, Md. (altitude about 600 to 1,000 feet), wheat sown after October 1 usually escapes injury from this pest. Farther south later seeding is necessary. Seeding should be delayed one day from October 1 for each 12 to 15 miles of distance south of Frederick County. There should also be a delay of one day for each decrease of 100 feet in altitude. Thus, in the Coastal Plain section of Delaware, where the altitude is 500 to 800 feet lower, seeding should be about one week later than in Frederick County, or about October 8. In the Coastal Plain section of southern Virginia, which is 125 to 175 miles farther south, there should be an additional delay of 10 to 15 days, making October 20 the safe date for seeding to escape Hessian-fly injury. The dates above mentioned are subject to considerable variation as a result of weather conditions. Excessive dampness tends to hasten the emergence period of the fly, while drought delays it. In no case should seeding be delayed so long that the plants do not make sufficient growth to withstand the winter. If sown on well-prepared soil at the dates here recommended, there will be little danger of loss from winter injury.

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[1] Johnson, E. C. The smuts of wheat, oats, barley, and corn. U. S. Dept. Agr., Farmers' Bul. 507, 32 p., 11 fig. 1912.

Winter rye may be sown with safety from one to two weeks later than wheat. However, earlier seeding of rye than is ordinarily practiced is recommended. In a varietal test of winter rye at the Arlington Farm, an experiment farm of the Department of Agriculture near Washington, D. C., excellent results have been obtained for several years by sowing this crop at the same time as wheat.

Winter oats should be sown a week to ten days earlier than wheat. For eastern and southern Maryland and eastern Virginia the best time for sowing is during the last two weeks of September and the first week of October. In West Virginia and in western and northern Maryland winter oats should be sown not later than September 10. In the mountain section of Virginia oats may be sown from September 1 to 20. Winter barley should be sown at about the same time as winter oats. In the Piedmont and mountain sections, winter barley should be sown about a week earlier than wheat.

METHOD OF SOWING.

In experiments in which drilling and broadcasting winter grains have been compared, better yields have usually been obtained from drilling. A more economical and uniform distribution of the seed, a higher percentage of germination, and a more even stand are among the chief advantages of drilling.

On a well-prepared seed bed containing plenty of moisture, from 1 to 1½ inches is a sufficient depth to sow winter grains. In dry seasons the depth should be increased to 2 or 3 inches, because the seed must reach moist soil to insure quick germination.

The drills commonly used in this section are equipped with various furrow-opening devices, which place the grain in rows 7 or 8 inches apart. The hoe, shoe, and disk drills all do good work on a well-prepared seed bed free from trash. For sowing on disked corn-stubble land or where there is other trash, the disk drill, preferably the single-disk type, is superior. The hoe and single-disk drills place the grain in a much more distinct furrow than either the shoe or double-disk drill. This is an advantage, as the ridges protect the plants from cold winds and also collect and hold snow. For this reason also drag chains, press wheels, and other leveling devices are not ordinarily used in drilling winter grains in this section.

RATE OF SEEDING.

On medium to fertile soils winter wheat should be sown at the rate of 6 pecks per acre. On highly productive soils 4 to 5 pecks are sufficient in a well-prepared seed bed. In a rate-of-seeding experiment conducted on the Arlington Farm for four years, as high yields of wheat have been obtained from seeding at the rates of 3 and 4 pecks per acre as from 6 and 7 pecks. It is not yet known how widely these results may be applied.

Winter rye should be sown at the rate of 6 pecks per acre. On very productive soils 4 to 5 pecks is a sufficient quantity of seed to sow.

Winter spelt should be sown at the rate of 3 to 4 bushels (90 to 120 pounds) per acre. As the kernels do not thrash free from the glumes (chaff or hulls) the grain is rather bulky. For this reason it is necessary to sow a large quantity of seed per acre.

Winter oats should be sown at the rate of 6 to 8 pecks per acre for all varieties other than those of the Red Rustproof group. These oats have large kernels with tufts of hairs at the base and with beards which do not break off in thrashing. Because of these characteristics the kernels do not pack together like those of other varieties, and they do not feed freely through the drill. For this reason 10 to 12 pecks of Red Rustproof oats should be sown to the acre.

Winter barley should be sown at the rate of 8 to 10 pecks per acre, preferably the former.

While these rates for the several classes of small grains are generally applicable in the section here discussed, allowances should always be made for poor germination, inferior quality of seed, a poorly prepared seed bed, lateness of seeding, and unproductive soil, and the rate of seeding should be increased accordingly.

HARVESTING.

WHEN TO CUT.

The small grains should be cut at the time when the largest yield of the best quality can be obtained. Wheat and other grains are ready to cut when only a slight tinge of greenness remains in the straw. The hardness of the kernel is also an indication of maturity, the grain being ready to cut when it is passing out of the hard-dough stage.

As the acreage of grain on most farms in this section is comparatively small, wheat and rye usually may be allowed to stand until fully ripe. If wheat is allowed to become overripe the bundles made by the self-binder are hard to shock. The loss by shattering in allowing oats and barley to stand after they have passed the hard-dough stage will be greater than the increase in yield of the crop through increase in weight.

SHOCKING.

Small grain should be shocked carefully in this section. The importance of good work in setting up a shock of grain is often not fully realized. When the work is not well done, a great number of shocks often go down or the caps blow off, causing damage to the grain and loss of the time necessary for resetting or recapping the shocks.

The chief objects in shocking grain are to allow it to cure properly and to protect it from sunshine as well as from dampness. The protection from sunshine is of more importance than is sometimes realized. The effect of sunshine is to bleach the grain and injure its quality.

The following method of shocking is convenient and satisfactory. The shock built by this method protects the grain and also stands up well. First, set up two bundles, flat sides together. Most binders make bundles which are not round, but somewhat flattened. These bundles should be set down with the butts slightly apart, squarely and firmly, so that they will stand alone under ordinary conditions. Next, set another bundle at each end of this pair, so that there will be four in a row. Then set one in the middle of each side. This will leave a space at each of the four corners, in which a bundle should be placed. There are now 10 bundles in the shock, which is about the proper number ordinarily. If the grain is very dry or overripe a few more bundles may be set around the shock where they seem to fit best. In making this kind of shock in windy weather it is better to set the third and fourth bundles at the sides instead of at the ends as just described. The end bundles may then be added and the shock completed as before. The result is the same in either case, but the latter method is easier when the wind is strong enough to interfere with the work.

When the required number of bundles is set up, the shock should be capped. There is some difference of opinion as to whether one or two bundles should be used for capping. One cap allows more circulation of air through the shock, so that the grain dries out more quickly if the shock becomes wet. Less labor is required also, as only one bundle has to be broken. The chief advantage in using two caps is the greater protection afforded, as the grain does not get wet so readily.

A bundle to be used for a cap is broken by supporting it with the butts on the knees and with one forearm and hand under it at the band, while the straw is broken over just above the band with the other hand. If one cap is used the grain end always should be placed in the direction of the prevailing winds. If two are used the second cap should be placed similarly and at right angles to the first. By devoting some attention to this detail very few caps will be blown off under ordinary weather conditions.

STACKING.

In Delaware, Maryland, and the Virginias, grain is often stored in barns from the time it is cured in the shock till it is thrashed. This is the most satisfactory method of handling the crop from a small acreage. If, however, there is not sufficient storage space, it should be stacked. In stacking, build a temporary base of fence rails or other light timbers to keep the stack from coming in contact with the ground and absorbing moisture from it. Usually two layers of timbers, the second placed at right angles to the first, will make a satisfactory foundation. The size of the foundation, of course, varies with the size of the stack which is to be built.

Begin at the center and complete each layer with the outside row (course) of bundles before beginning another layer. The heads of each bundle should point toward the center of the stack. Gradually increase the diameter of the stack with each layer until the proper bulge is formed. Then decrease the diameter by drawing in the outside row of each layer slightly, in order to build the top of the stack properly. This is simply the reverse of the process of making the bulge.

The most important point to keep in mind in building a stack that will shed water is to keep the middle full, well tramped, and a little higher than the rim. If a few bundles slide off in the progress of the stacking it is much better than to have the stack take water when settled.

The top of the stack may be prevented from blowing off by tying the ends of two light timbers together with wire or rope and hanging them across it. More than one of these binders may be used if necessary. Where a stack is allowed to stand for several months it is usually advisable to cover it with canvas, straw, coarse hay, or some other material, to protect the top of the stack.

THRASHING.

The thrashing of any small-grain crop should never be attempted when it is damp or when it is passing through the sweat. It will not only be difficult to thrash—the straw wrapping around the cylinder and the shafts of the separator—but all the grain may not be removed from the straw. If grain is thrashed when damp there is danger that it will heat and spoil in the bin. If the farmer wishes to keep his variety as pure as possible, it is advisable to keep the first 25 to 50 bushels thrashed separate from the remainder of his crop, for by so doing the danger of mixing the variety grown on his neighbor's farm with that on his own is reduced to a minimum. When the bulk of the crop is not to be utilized for seed, enough grain for sowing on one's own farm and for sale to any neighbors who may want to buy or exchange seed may be set aside when the crop is about half thrashed.

VARIETIES TO GROW.

The best measure of the value of any variety of wheat or other small grain is its yield in bushels per acre in comparison with other and similar varieties. No other quality is so important as the ability of a variety to produce a high average yield. Varietal experiments with the various fall-sown grains have been conducted by the Office of Cereal Investigations of the United States Department of Agriculture at Arlington Farm, near Washington, D. C., and in cooperation with the Maryland Agricultural Experiment Station at College Park, Md.[1] The methods used in growing the varieties in these tests were as similar as possible to those used in good farm practice in the sections of Maryland and Virginia to which the results are believed to be applicable. Every effort was made to secure uniform conditions, so as not to give one variety or group of varieties any undue advantages over others. These tests have been conducted for five to eight years.

Varietal experiments with winter grains have also been conducted by the State agricultural experiment stations at Newark, Del., Blacksburg, Va., and Morgantown, W. Va. None of these stations has issued bulletins recently on the results of their experiments with these crops, but the recommendations here made are based on recent correspondence with the agronomists who are conducting the tests.[2]

WINTER WHEAT.

Varieties of winter wheat have been tested for eight years at College Park (Md.) and for seven years at Arlington Farm (Va.). During this period the leading red wheats at College Park have been China and Currell, beardless varieties with smooth brown chaff, and Mammoth Red, Bearded Purple Straw, Turkish Amber, Fulcaster, and Dietz, all bearded wheats with smooth white chaff. Bearded Winter Fife, a white wheat with bearded heads and hairy white chaff, has also yielded well. The leading varieties of red wheat at Arlington Farm have been Purple Straw and Fultz, beardless with smooth white chaff; Poole, beardless with smooth brown chaff; and Fulcaster, bearded with smooth white chaff. Of the white wheats, Dawson has yielded best. The average yields of these varieties at College Park and Arlington Farm for the periods mentioned range from 29 to 32 bushels. Heads of several of these varieties are shown in figure 1.

For Delaware, the bearded varieties recommended are Rudy, Red Wonder, Gipsy, and Stoner (Miracle). The best beardless varieties are Leap, Poole, and Currell. In general, the bearded varieties have given better results than the beardless ones. At the Virginia Agricultural Experiment Station, Fulcaster, Stoner (Miracle), and Mediterranean are the leading bearded varieties, with Leap and Fultz among the best beardless ones. At the West Virginia station, Poole, Currell, Fulcaster, Fultz, and Dawson are recommended.

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[1] For full details of these tests, see Stanton, T. R., Cereal experiments in Maryland and Virginia. U. S. Dept. Agr. Bul. 336, 51 p., 6 fig. 1916.

[2] The data on varietal experiments at their respective stations have been supplied by Messrs. A. E. Grantham, T. B. Hutcheson, and I. S. Cook, jr., agronomists of the Delaware, Virginia, and West Virginia agricultural experiment stations, respectively.

These experiments show that numerous varieties do well in the section under discussion. Many of these, however, are very similar, and often several names are used for what is really only one variety. Among the varieties which can be most strongly recommended are the following:

For the Coastal Plain.—Bearded varieties: Fulcaster, Gipsy, Red Wonder, Rudy, and Stoner (Miracle). Beardless varieties: China, Currell (Currell Prolific), Fultz, Leap (Leap Prolific), and Poole.

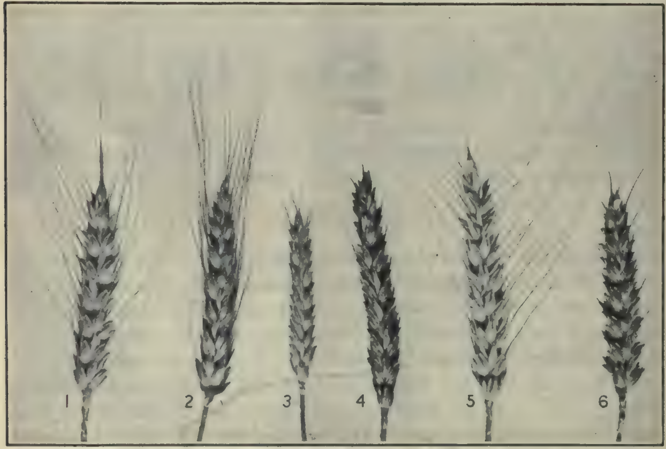

FIG 1.—Heads of six varieties of winter wheat grown at the Maryland Agricultural Experiment Station and at Arlington Farm: 1, Dietz (Dietz Longberry); 2, Missouri Bluestem; 3, Purple Straw; 4, China; 5, Bearded Winter Fife; 6, Dawson Golden Chaff.

For the Piedmont area.—Bearded varieties: Bearded Purple Straw, Dietz, Fulcaster, and Mammoth Red. Beardless varieties: China, Currell (Currell Prolific), Dawson (Dawson Golden Chaff), Fultz, Poole, and Purple Straw.

For the mountain section.—Bearded varieties: Fulcaster, Gipsy, and Rudy. Beardless varieties: Currell (Currell Prolific), Dawson (Dawson Golden Chaff), Fultz, Harvest King, and Poole.

Of the above all are red wheats except Dawson (Dawson Golden Chaff), a white-kerneled variety. This white wheat yields well, but is not as good for flour as the red wheats.

WINTER SPELT AND EMMER.

Varieties of spelt and emmer have been tested for seven years at College Park and for six years at Arlington Farm. These grains are closely related to wheat, but they do not thrash free from the hull.

They are used as feed for domestic animals and are quite similar to oats in feeding value. At College Park the Alstroum and Red Awnless varieties of spelt have given 6-year average yields of 73 and 70 bushels of 30 pounds each, respectively, while at Arlington Farm they have made 6-year averages of 75 and 73 bushels, respectively. Both are beardless varieties. The Alstroum has white glumes (chaff), and the Red Awnless has red chaff. Black Winter emmer has produced very low yields as compared with spelt. It has produced 6-year average yields of 37 and 23 bushels of 30 pounds each at College Park and Arlington Farm, respectively. The Alstroum and Red Awnless spelts are recommended for growing for feed in place of oats and barley, as they yield more grain than either of these crops. Heads of spelt and emmer are shown in figure 2.

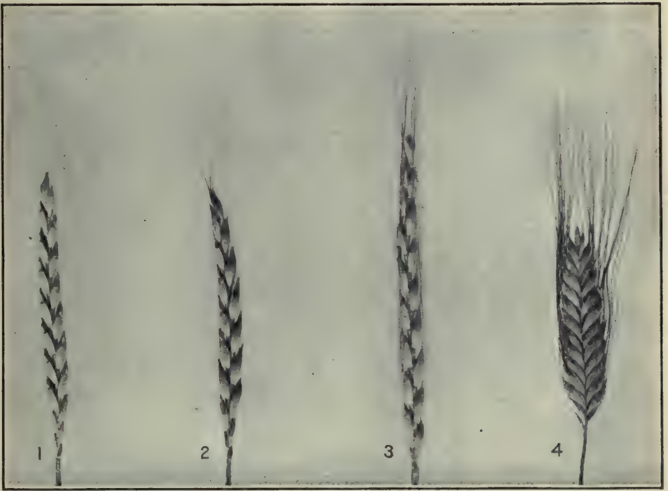

FIG. 2.—Heads of three varieties of spelt and one variety of emmer grown at the Maryland Agricultural Experiment Station and at Arlington Farm: 1, Alstroum spelt; 2, Red Awnless spelt; 3, Servia spelt; 4, Black Winter emmer.

WINTER RYE.

Varieties of winter rye have been tested at the Arlington Farm for five years. Practically all the varieties tested have yielded well. The leading ones are Giant Winter, Abruzzes, and Virginia Winter, with average yields for the period tested of 37, 36, and 35 bushels, respectively. These are tall, vigorous-growing, large-strawed varieties, producing large brownish yellow kernels. Heads of these varieties are shown in figure 3. The varieties of rye which have proved most satisfactory at the Virginia station are Thousandfold, Abruzzes, and Virginia Winter. No varieties are especially recommended for Delaware and West Virginia. It is sometimes difficult to obtain named varieties of rye on the market in this section, "winter" rye being commonly sold. This is usually the rye here recorded as Virginia Winter. The differences in yield and appearance among most of the more common varieties of rye are not great, and in this section any good winter rye should give satisfactory results.

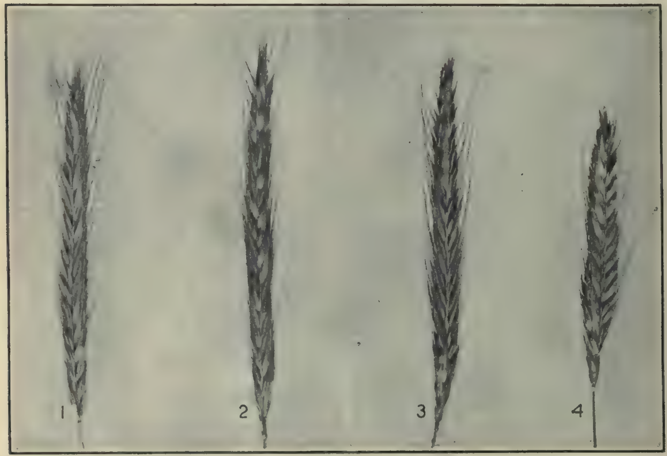

FIG. 3.—Heads of four varieties of winter rye grown at Arlington Farm: 1, Giant Winter; 2, Virginia Winter; 3, Abruzzes; 4, Henry.

WINTER OATS.

Varieties of winter oats have been tested for eight years at College Park and for five years at Arlington Farm. For this period the leading variety at College Park has been Winter Turf (Virginia Gray), a late-maturing oat. Culberson, a medium-early variety, has also yielded well. At Arlington Farm, Winter Turf has been the leading variety. Other varieties that have yielded well at Arlington Farm are Culberson and Red Rustproof, an early large red oat. At College Park, Culberson and the best strain of Winter Turf have made average yields for seven years of 46 and 51 bushels, respectively. At Arlington Farm the best strains of Culberson, Red Rustproof, and Winter Turf have given 5-year average yields of 43, 43, and 47 bushels, respectively. At the Virginia Agricultural Experiment Station Winter Turf and Culberson are best.

The Winter Turf oat is hardier than the Red Rustproof and Culberson and is specially recommended for the Piedmont and mountain sections and for Delaware. In the Coastal Plain sections of Maryland and Virginia, the Red Rustproof and Culberson are to be preferred because of their earlier maturity. Heads of these varieties are shown in figure 4.

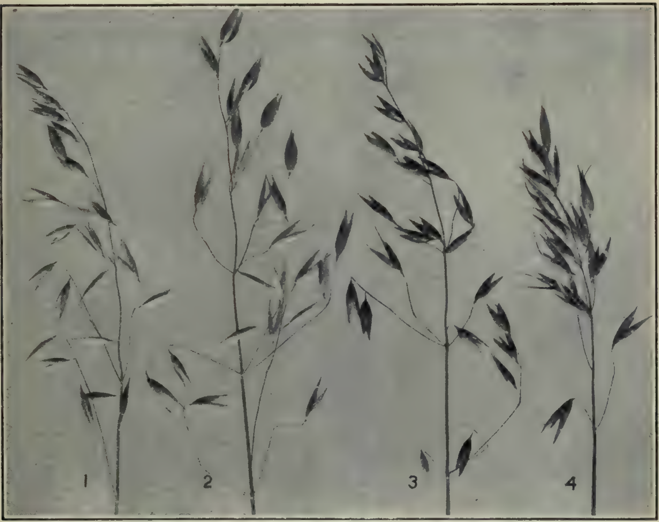

FIG. 4.—Heads of four varieties of winter oats grown at the Maryland Agricultural Experiment Station and at Arlington Farm: 1, Culberson; 2, Bicknell; 3, Winter Turf; 4, Red Rustproof.

In West Virginia, in the mountain sections of Maryland and Virginia, and in Delaware winter oats often winterkill. When they survive the winter, however, they yield much better than spring oats. The best insurance against winterkilling is early sowing. If the Winter Turf (Virginia Gray) is sown early in these sections (not later than September 15 to 20), winterkilling will be experienced only during the most severe winters. Only a very small proportion of the oat crop of West Virginia and western Maryland is sown in the fall.

WINTER BARLEY.

Varieties of winter barley have been tested for eight years at College Park and for seven years at Arlington Farm. For this period the leading variety at both places has been the Tennessee Winter, a bearded, 6-rowed form. The average yields of this variety for seven years at College Park and Arlington have been 34 and 29 bushels, respectively. Varieties known as Maryland Winter and Union Winter are practically identical with the Tennessee Winter. Of the varieties of winter barley that have been tried by the Virginia Agricultural Experiment Station, Tennessee Winter and Union Winter seem best adapted. Heads of winter barley are shown in figure 5.

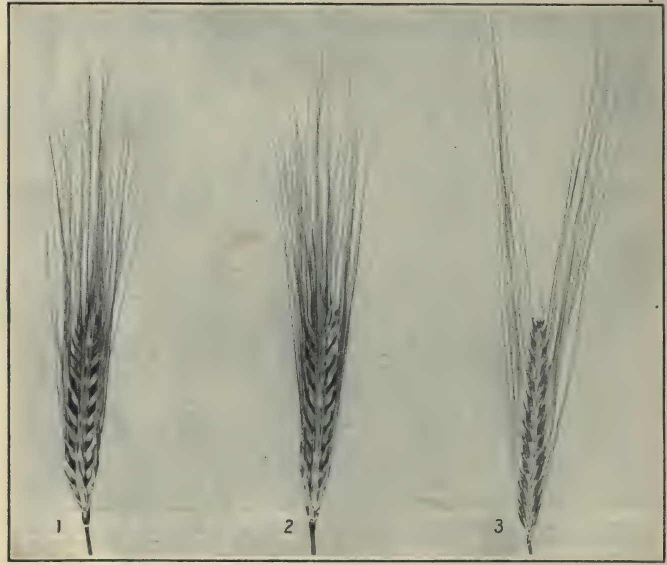

FIG. 5.—Heads of three varieties of winter barley grown at Arlington Farm: 1, Tennessee Winter; 2, Wisconsin Winter; 3, Omar.

Winter barley is hardier than winter oats and can be grown successfully anywhere in Delaware, Maryland, and the Virginias, except perhaps at the greatest elevations. Early seeding is necessary to insure success, however, in the mountain sections and in Delaware. The bearded varieties are hardier than the beardless (hooded) ones, and only the former should be grown. Hooded or beardless barley is often highly recommended in this section, particularly for hay and pasture, but it is not a safe crop to grow from fall seeding. Tennessee Winter and other similar bearded varieties make excellent fall and spring pasture, but they are somewhat objectionable for hay because of the long, stiff beards.

COMPARATIVE RETURNS.

The comparative returns from the various small-grain crops are of vital interest in determining which one to grow. As an indicator of the relative value of these crops in Delaware, Maryland, Virginia, and West Virginia, the average yield per acre of each crop in each State for the 10-year period from 1906 to 1915, inclusive, is presented in Table II. The yields are given both in bushels and in pounds. The acre value of each crop is also given. These values are figured on the average acre yields and average farm price per bushel in each State, as reported by the Bureau of Crop Estimates.

TABLE II.—*Average yields and farm values of wheat, rye, oats, and barley in Delaware, Maryland, Virginia, and West Virginia, for the 10-year period, 1906 to 1915, inclusive.*

State.	Yield per acre (bushels).				Yield per acre (pounds).				Value per acre.			
	Wheat.	Rye.	Oats.	Barley.	Wheat.	Rye.	Oats.	Barley.	Wheat.	Rye.	Oats.	Barley.
Delaware	16.7	15.2	29.5	......	1,002	851	944	......	$15.86	$8.51	$14.16	......
Maryland	16.5	15.4	28.0	30.3	990	862	896	1,454	15.67	8.62	13.44	$18.79
Virginia	12.6	13.0	20.2	27.2	756	728	646	1,306	12.60	7.28	10.50	19.04
West Virginia	13.2	13.0	22.9	......	792	728	733	......	13.46	7.28	11.68	......

As shown in Table II, wheat ranks highest in pounds of grain produced and in acre value of the crop in Delaware and in West Virginia. In Maryland and Virginia it is considerably exceeded in both respects by barley, a crop which is grown on only a small acreage and is not reported at all for the other two States. Oats rank next to wheat in value in every State, rye being lowest in every case. The acre yield of rye in Virginia is higher than that of oats, but is lower in the other States.

The figures for oats and barley in Table II are not entirely comparable with those for wheat and rye, for no separation is made by the Bureau of Crop Estimates of the spring-sown and fall-sown crops. The wheat and rye in these States are practically all fall sown, while much of the oats and some of the barley are spring sown, particularly in Maryland and West Virginia.

A more reliable basis of comparison for the various crops in the Piedmont and Coastal Plain sections is afforded by the average yields obtained at Arlington Farm, Va., and at College Park, Md. Yields and values of the highest yielding varieties of each crop are shown in Table III. The yields at each place are all for the same period of years and all the grains were grown under very similar conditions. All were sown in the fall.

TABLE III.—*Average acre yields and acre values of the highest yielding varieties of the various fall-sown grains at Arlington Farm, Va., and at College Park, Md., for stated years.*

Place, period, and crop.	Yield per acre.		Value per acre.
	Bushels.	Pounds.	
Arlington Farm, 5-year period, 1911 to 1915, inclusive:			
Purple Straw wheat	33.45	2,007	$34.11
Alstroum spelt	68.88	2,066	....
Giant Winter rye	34.25	1,918	29.99
Winter Turf oats	47.53	1,521	26.14
Tennessee Winter barley	27.57	1,323	20.61
College Park, 6-year period, 1909 to 1914, inclusive:			
Bearded Purple Straw wheat	30.62	1,837	29.62
Alstroum spelt	63.23	1,897	....
Winter Turf oats	49.30	1,578	23.78
Mammoth Winter barley	34.99	1,679	22.81

According to Table III, the highest yield of grain in pounds at each place was produced by Alstroum spelt. As this grain is not commonly grown, however, and is not readily marketable, it is not possible to compare it with the other crops in acre value. Because of its high yield it should be a valuable grain to grow on farms where it can be fed to live stock. At Arlington Farm, rye has yielded only slightly less than wheat and ranks next to it in acre value. This crop was not included in the tests at College Park. Oats and barley rank considerably below wheat in both yield and value, oats exceeding barley in value at both farms.

According to the figures here presented, wheat is the most profitable of the fall-sown grain crops in this section, rye, oats, and barley following in order. The high yields obtained from rye at Arlington Farm are evidence of the ability of that crop to yield profitable returns when sown reasonably early on fertile, well-prepared land. The low yields of rye commonly obtained are due to the fact that the crop is usually sown very late and on poor soil.

The yields of the various crops on the two experiment farms are double or more than double the average yields in Maryland and Virginia, as reported by the Bureau of Crop Estimates. This is an indication that the average yields can be materially increased if only the best varieties are grown and proper attention is given to the preparation of the land, its fertility, and the time and rate of seeding.

SUMMARY.

The essentials for the profitable production of fall-sown grains in Delaware, Maryland, and the Virginias may be summarized briefly as follows: A well-drained soil; proper fertilization; a good system of crop rotation; a well-prepared seed bed; good, pure, cleaned, and graded seed which has been treated for smut; seeding at the proper time and rate; and growing adapted, high-yielding varieties. The best varieties for these States are the following:

WHEAT.

- Bearded varieties:
  - Dietz.
  - Fulcaster.
  - Gipsy.
  - Rudy.
  - Stoner.
- Beardless varieties:
  - China.
  - Currell (Currell Prolific).
  - Fultz.
  - Leap (Leap Prolific).
  - Poole.
  - Purple Straw.
  - Dawson (Dawson Golden Chaff).

RYE.

Abruzzes.
Giant Winter.
Virginia Winter.

SPELT.

Alstroum.
Red Awnless.

OATS.

Culberson.
Red Rustproof.
Winter Turf.

BARLEY.

Tennessee Winter.
Union Winter.

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Cereal Experiments in Maryland and Virginia. (Department Bulletin 336.)

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UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN

WASHINGTON, D. C. 787 DECEMBER 30, 1916

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

SEA ISLAND COTTON.[1]

By W. A. ORTON,

Pathologist in Charge of Cotton and Truck Disease Investigations.

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INTRODUCTION.

Sea Island cotton is grown for its unusually long and silky fiber, which is used for making fine fabrics and laces. It is used also where great strength and durability are required, as in the manufacture of cloth for the best grades of automobile tires.

Sea Island cotton differs from the ordinary Upland cotton in many respects. The plant is taller, the leaves smoother and more deeply lobed, the flowers brighter yellow, the bolls smaller, longer, and more pointed, the seed nearly bare of fuzz, and the staple longer and finer. It is more closely related to Egyptian cotton, which it resembles in appearance.

As indicated by its botanical name, *Gossypium barbadense*, the original home of the plant is thought to have been the West Indies. When first introduced into the mainland of America, about 1786, it is reported to have been considerably different from the present form.

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[1] This bulletin is a revision of Farmers' Bulletin 302, entitled "Sea Island cotton: Its culture, improvement, and diseases," issued in 1907. It is intended for distribution in Florida, southern Georgia, and the coast counties of South Carolina.

The plant was a perennial--larger, later, and less productive than now. The method of culture described on page 15 was adopted to reduce the size of the plant and stimulate fruitfulness, but the great change that has been wrought is due mainly to careful breeding. Through several generations the planters have selected seed from the earliest, most compact, and most productive plants with the longest and finest staple, until the character of the plant has been radically changed.

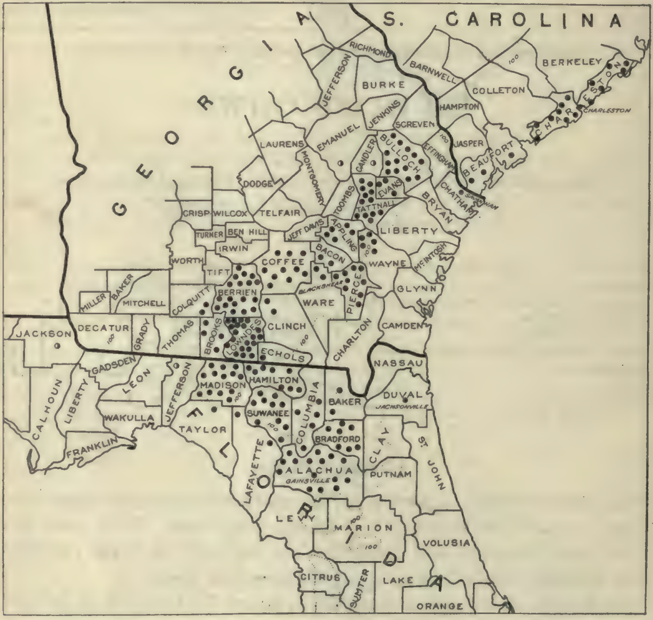

FIG. 1.—Map of the Sea Island cotton area of the United States, showing distribution by counties. Each dot represents an average production of 500 bales.

GEOGRAPHICAL DISTRIBUTION OF SEA ISLAND COTTON IN THE UNITED STATES.

The successful cultivation of Sea Island cotton in this country is confined to the area lying southeast of a line drawn from Georgetown, S. C., to a point in western Florida. The accompanying map, figure 1, shows the approximate quantity produced in each county in this district, each dot standing for 500 bales.

In South Carolina the center of production is on the Sea Islands along the coast, where the finest staples are grown. The chief of these islands are James, Edisto, John, and Wadmalaw.

It is interesting to learn that in Georgia the coast counties produce scarcely any cotton, owing to the unfavorable character of the country, the absence of the necessary labor, and the predominance of the lumbering and trucking industries. The interior counties which grow Sea Island cotton extensively also produce a considerable quantity of Upland cotton.

In Florida a similar condition exists. Cotton is not grown on the coast, but is confined to the interior counties in the north-central portion of the State. Here the proportion of Upland to Sea Island cotton is much smaller until one reaches the western counties, where conditions are less favorable for the long-staple cotton and where the Upland type is mainly grown.

The annual crop fluctuates widely, according to the nature of the season, but the average yield in bales of not quite 400 pounds each during the five years from 1910 to 1914 has been as follows: South Carolina, 8,022 bales; Georgia, 50,055 bales; and Florida, 30,454 bales.

It is quality rather than quantity that gives economic importance to the Sea Island cotton industry, for the total annual production is less than 1 per cent of the American crop.

IDEAL CROP REQUIREMENTS.

Several factors must be considered when seeking a location for growing Sea Island cotton. Those mentioned here affect not only the yield but the quality of the staple, its color, and the percentage of lint to seed. The relative influence of the various factors is, however, not always determinable.

SOIL.

The crop requires a sandy or a sandy loam soil, preferably with a clay or compact sand subsoil about a foot below the surface. Most of the Sea Island cotton is grown on the soil type classified by the Bureau of Soils as Norfolk fine sand, with lesser areas of Norfolk sand, Norfolk sandy loam, and related types. On the Sea Islands, where a clay subsoil is rarely found, the growers seek to maintain a compacted layer beneath the plants by the tramping of stock during the year the land is resting. The interior growers prefer a clay subsoil, but sometimes plant cotton on quite deep sand, where the quality is satisfactory; the yield is smaller, however, in such cases.

MOISTURE.

A well-regulated water supply is the most important factor influencing Sea Island cotton. Thorough drainage is essential. On this account more and better cotton is grown on the slightly elevated margins of the Sea Islands than in the lower central portions. Tile drains make possible the cultivation of land otherwise too wet. In the interior, cotton is grown only where there is suitable drainage.

On the other hand, a liberal and regular supply of water is needed, and wherever cotton is planted on the dry hills in the upper edge of the Sea Island cotton belt inferior results are secured, the staple becoming shorter and harsher. The lower lying lands are better, provided they have adequate drainage.

HUMUS.

Soils very rich in humus appear to be unsuited to Sea Island cotton, producing too rank a growth; but a deficiency of humus is also a serious objection, as such land produces a small plant with a tendency to the shedding of bolls and to rust.

LOCATION AND EXPOSURE.

Atmospheric humidity appears to be a prominent factor influencing the quality of the staple. On the Sea Islands, fields having an ocean exposure are said to produce a finer and glossier staple on account of the moisture-laden ocean breezes, and in the interior one advantage of the lower lands is doubtless their moist air, which is conserved by protecting forests and near-by swamps. In the absence of sufficient moisture in the air the staple becomes harsh and shorter. This is further shown by the fact that a wet season is more favorable to Sea Island than to Upland cotton, while the Upland varieties do better in a dry season. The relative production of Upland and Sea Island cotton in the northern counties fluctuates with the season and the changes in acreage due to varying market conditions.

The mixing of seed and the hybridization which result from planting cotton of both types in the same community are a serious handicap to the growers of Sea Island cotton. In this respect portions of Florida where only Sea Island cotton is grown possess a marked advantage, and the introduction of Upland varieties should be discouraged.

LABOR.

In addition to the effect of high prices in stimulating the industry and of low prices in depressing it, a factor which must be considered in connection with the production of cotton in either old or new sections is the supply of available labor. Until present methods are revolutionized a relatively large amount of fairly cheap labor is required, and it is a great advantage if the laborers have had long experience with the crop. Throughout the Sea Island cotton belt there is now a growing scarcity of labor, which is likely to restrict the acreage planted. The farmers must meet the new conditions by the adoption of labor-saving machinery in planting and in cultivation, but there will continue to be difficulty in getting the cotton picked.

The development of trucking and lumbering industries restricts the less profitable cotton crop, and there is a steady exodus of laborers to engage in railroad building, etc., making the labor problem still more serious.

POSSIBLE EXTENSION OF THE SEA ISLAND COTTON-PRODUCING AREA.

There is little encouragement to offer to those who would attempt to introduce the culture of Sea Island cotton into other parts of the country than where it is now grown. Many such trials have been made during the past hundred years, and all have failed. Even in the present area the crop is losing rather than gaining ground in competition with Upland cotton, although the production of Sea Island cotton might be increased if market conditions warranted.

Serious obstacles are met with in introducing Sea Island cotton into a new section. There is difficulty in securing the proper care in cultivation and in picking and handling the staple. Pickers accustomed to Upland varieties object so much to the small and partly closed Sea Island bolls that it is difficult to get the cotton picked even at the prices now paid—$1 to $1.25 a hundred pounds. The ginning must be done on a roller gin, as the saw gin injures the staple too much, and a specially equipped ginnery is therefore necessary. Further difficulties are met with in marketing the product, which at first can rarely be sold to advantage in a local market where the buyers are unaccustomed to the Sea Island staple. Shipment to a recognized market for Sea Island cotton is necessary in such cases.

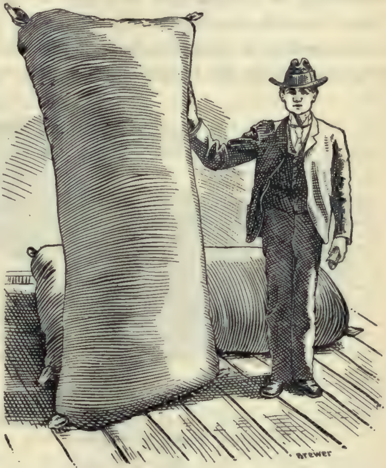

FIG. 2.—A bag of cotton on the Sea Islands ready for shipment.

MARKETS.

The cotton grown in South Carolina is marketed at Charleston, while the interior crop is handled at Savannah, Blackshear, and Valdosta, Ga., Alachua and Madison, Fla., and other interior towns. There is a marked difference in the style of bale in the two cases. South Carolina cotton is put up in bags, 7½ feet long and about 2½ feet in diameter, containing 300 to 400 pounds. (Fig. 2.) They are filled by hand and pressed in a light hand-screw press. Compression for export is not practiced. As the use of this bag has been confined to the Sea Islands, it serves as a trade-mark to distinguish the crop in foreign markets.

In the Charleston district the finest cotton is that grown by a limited number of planters who have for many years paid the most careful attention to seed selection. Their cotton is not only long and fine but is picked with so much regard to cleanliness and uniformity that the grower's private brand on the package is often a sufficient guaranty of its quality.

These fine "crop lots" comprise about 35 per cent of the cotton marketed in Charleston and sell for from 30 to 60 cents a pound. They are all exported. The demand for this extra-fine and high-priced cotton is very limited. The remainder of the South Carolina crop is sold in the usual manner at lower prices. The higher price secured for South Carolina cotton is largely because of its superior preparation, all stained and weak cotton and bits of leaf being removed before baling.

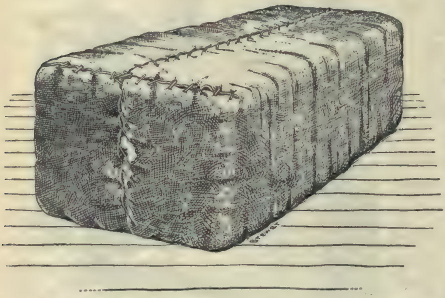

FIG. 3.—A bale of Sea Island cotton in the interior cotton region ready for shipment.

Interior Sea Island cotton is packed by a steam press into bales weighing about 400 pounds each, of the same shape and size as an Upland cotton bale, 54 by 27 inches. (Fig. 3.) They are covered with heavy burlap, secured by sewing with strong cord instead of by the steel ties used on bales of Upland cotton.

The buyers classify interior cotton first by length of staple, but little or no distinction is now made as to whether the cotton comes from Georgia or Florida, provided the body, staple, and grade are satisfactory. The length of staple is mainly influenced by seed selection, but in part by the character of the soil. Each of these classes is subdivided into grades with reference to its preparation and appearance, the usual grades being fancy, extra choice, choice, extra fine, fine, and "dogs." The difference of 5 to 10 cents a pound between fancy and fine shows the possible gain to the farmer from careful preparation. Loss of grade is due to exposure to weather before picking, to storing or ginning when too wet, and especially to the presence of stained or yellow cotton and bits of leaf or other trash.

FACTORS GOVERNING PRICES.[1]

There is a fairly uniform demand for a few hundred bags of extra-fine cotton with staple of 2 inches and over, and, for what the market requires, a high price, 50 to 80 cents a pound, will be paid. A larger quantity of this long-staple cotton is difficult to sell at any price. For the medium grades (1⅝ inches to 1⅞ inches) there is a liberal demand at prices determined by the law of supply and demand. The size of the crop in Georgia and Florida is the principal factor in establishing the price, but other long staples exercise considerable influence.

Sea Island cotton is only slightly affected by the fluctuations of short-staple Upland cotton, but the amount and quality of the long-staple Upland crop seriously affect the lower grades of Sea Island cotton. Staples less than 1⅝ inches long sell well only in a year when the long-staple Upland crop is inferior. This long-staple Upland cotton is grown mainly in the Mississippi Valley, and as it can be produced at a less cost than Sea Island cotton, it is evident that the latter must not be permitted to become less than 1⅝ inches in length, in order to avoid this competition.

The next quality of staple competing with Sea Island cotton is the Egyptian, which has become the dominating factor in the price for long-staple cotton. Of this, an amount equivalent to from 1 to 1½ million 500-pound bales is produced every year in the Nile Valley, and the equivalent of from 115,000 to 230,000 such bales are annually imported into America. An average price is 19½ cents a pound. Egyptian, while not as long and fine as Sea Island cotton, is very strong and free from waste, owing to careful preparation. Its waste in the process of manufacture is somewhat less than that for Sea Island cotton. Much of the Egyptian cotton is decidedly shorter than Sea Island cotton, but the Sakellaridis variety is in marked competition with Sea Island of 1⅝-inch staple or less and will continue to be used by many mills in preference to the American cotton until the Sea Island growers improve their product.

The Egyptian, although closely related to Sea Island cotton, can not be grown in our Southeastern States on account of its susceptibility to the bacterial disease black-arm; but it has been successfully introduced into Arizona.

Sea Island cotton produced in the West Indies is equal to the average American product, and, indeed, competes with the Carolina Sea Island cotton rather than with the interior product. The industry in the British West Indies is comparatively new, having been developed mainly since 1902, and is as yet of small proportions; but the production there may increase. Dr. Francis Watts[1] gives the output of Sea Island cotton from the several British West Indian islands during the past five years as follows:

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[1] For a recent discussion of this subject, see Meadows, W. R., Economic conditions in the Sea Island cotton industry, U. S. Dept. Agr. Bul. 146, 18 p. 1914.

		Pounds.
Barbados		2,180,032
St. Vincent		2,110,613
Montserrat		1,715,773
Antigua		765,137
St. Kitts-Nevis:		
St. Kitts	1,806,284	
Nevis	1,249,875	
Anguilla	485,997	
		3,542,156
Virgin Islands		184,511
Total		10,498,222

Interior planters are advised not to aim to produce an extra-long cotton. South Carolina and the West Indies can excel in this, and the market for such cotton is very limited. Furthermore, the increase in length is obtained at a sacrifice in yield which cancels the profit. Rather let the interior grower select for a staple 1$\frac{5}{8}$ inches long and for a vigorous and productive plant and avoid the planting of Upland cotton near Sea Island fields.

DEFECTS IN ECONOMIC CONDITIONS.

The cost of cotton production is greatly increased by the prevailing credit system, owing to the higher cost of supplies and the reduction of the farmers' ambition and efficiency. The change from credit to a cash system now going on is a great gain for good farming and should be encouraged.

The common practice of renting land for a share of the crop greatly hinders the adoption of improved methods. It means instead the continuous planting of cotton without attention to seed selection or soil improvement. When the owner can not operate his farm himself, he should retain strict oversight over the work done by his tenant and provide, through a written contract, for a specified system of rotation and seed selection.

If the period of rental were three or five years instead of one, there would be more incentive for the tenant to build up the soil. The owner who keeps his land in a high state of cultivation has no difficulty in securing the best class of tenants.

There is a tendency among cotton buyers to pay an average price for all grades of Sea Island cotton, especially in the smaller markets. This means that good cotton brings less than its value, and inferior or dirty cotton too much. This practice is an injustice to the farmer who produces a superior article, and it tends to discourage him from selecting for quality. Unless buyers are willing to pay full value for the best cotton, farmers can not be expected to improve their seed in any respect except to secure larger yields per acre.

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[1] Watts, Francis, Cotton growing in the West Indies. *In* Agr. News [Barbados], v. 15, no. 364, p. 118. 1916.

It is an advantage to the farmer who has a superior grade of cotton to secure competitive offers from large buyers before selling. In this direction much good can be done by farmers' organizations.

CULTIVATION OF SEA ISLAND COTTON.

ROTATION AND DIVERSIFICATION.

Although Sea Island cotton always has been grown on the one-crop plan even on the Sea Islands, there are many reasons why greater success can be had by making it a part of a system of diversified farming.

By rotation of crops several purposes are accomplished, as follows:

(1) The productive capacity of the land is increased and maintained. The cultivation of cowpeas, velvet beans, and other legumes adds to the soil large quantities of nitrogen drawn from the air, enabling the farmer to secure at slight expense an element which is the most costly part of purchased fertilizers.

The physical condition of the soil is improved, especially by the addition of humus or vegetable mold, whereas continued cultivation in cotton or corn rapidly exhausts the humus. The importance of humus can hardly be overestimated. A soil rich in organic matter is more easily cultivated than other soil. It suffers less from washing, because the water is absorbed, and because of this water-holding power it does not quickly become too wet, nor does it dry quickly; hence, injury from drought is lessened. A soil rich in organic matter is richer in the beneficial bacteria and other organisms that take part in rendering available to the plant the food hitherto locked up.

By rotation, crops with different fertility requirements are alternated so that the same elements are not drawn on so constantly. Cover crops which increase humus can succeed cultivated crops which exhaust it, and in the intervals of rotation any poisonous or injurious excretion from the roots of a crop is neutralized. Deep-rooted crops may be employed to bring up plant food from the subsoil and leave it at the surface when they decay, where it will be available for shallower rooted crops.

The test of successful farming is to produce large and profitable crops and at the same time to build up the fertility of the soil, making it each year more productive. Diversified farming permits this to be done; continuous cotton growing never will.

(2) A diversified cropping system places farm operations on a safer and more economical basis. Regular and continuous employment for labor is secured if crops are grown which require attention at different seasons. The danger of loss from unfavorable weather or glutted markets is much diminished when several crops are grown. It is particularly important that the growers of Sea Island cotton should begin at once to practice diversification in order to gain experience with other crops, because there is a possibility that the invasion of the boll weevil into the Eastern States may in a few years make Sea Island cotton an unprofitable crop. Much hardship will result unless other crops are established meantime.

(3) Rotation of crops is one of the most effective means of controlling weeds, insects, and plant diseases. Crab-grass, nut-grass, and other weeds troublesome in cotton fields are reduced in numbers by the shading and smothering effect of a heavy growth of cowpeas or velvet beans.

Most injurious insects and plant diseases attack only one kind of plant. The continuous culture of any crop affords ideal conditions for the multiplication of its pests, while rotation of crops results in their destruction from lack of food. For example, the nematode worm, causing the destructive root-knot of peaches, cotton, etc., is greatly increased by planting susceptible crops, but can be controlled by a succession of immune crops, such as corn, oats, velvet beans, or peanuts. For several cotton diseases, including anthracnose, boll-rot, and black-arm, rotation is advised as one of several preventive measures.

ROTATION SYSTEMS.

The term "rotation" implies a prearranged order of succession for the various crops cultivated. Every farmer should draw up a planting scheme for his farm, worked out with reference to the relation of each crop to the others. The details of this plan will differ in every case according to the number of crops and the acreage of each, but some general principles apply to all.

The crops in a rotation may be divided into two classes:

(1) Money crops, in the majority of cases Sea Island cotton or truck crops, from the sale of which the principal income is derived. These draw from the soil more than they add to it.

(2) Improvement crops, grown mainly to build up the soil. These are usually legumes, such as cowpeas, velvet beans, peanuts, or beggarweed. If fed to stock they will return a revenue and improve the soil as well.

The choice of a legume.—Cowpeas have always been the most popular and widely grown crop of this class. They have many advantages over the others—adaptability to poor land, ease of culture, the value of the peas as food for man or stock, excellence as a hay crop, etc. On the other hand, most varieties are open to the serious objection that they are very subject to root-knot and greatly increase this disease. On land infected by cotton wilt or black-root the loss is increased by the presence of root-knot. Fortunately, the Iron cowpea is immune to root-knot and can be used with safety. In fields where it is certain there is no root-knot any pea can be planted, but the trouble is that root-knot frequently appears where its presence was not suspected. As all Sea Island cotton lands are sandy and subject to infection by root-knot and wilt, it is urged that no other cowpea than the Iron or Brabham varieties be used in rotation with Sea Island cotton.

Velvet beans are a great addition to the resources of Sea Island cotton growers. They are entirely immune to root-knot and black-root and of much value in rotations for this reason. No other legume grown in the Sea Island cotton belt makes as much growth or adds as much vegetable matter and nitrogen to the soil. Velvet beans afford excellent grazing for stock in late fall and winter, and should be grown much more than at present. Their long season of growth is a disadvantage when a catch crop is needed to follow potatoes or grain. The vines are so long that harvesting for hay is nearly impossible.

Peanuts, or ground peas, are also free from root-knot, and are especially useful as feed for hogs. They appear to be somewhat less effective as soil improvers than cowpeas.

Beggarweed is native to Florida and seeds itself whenever permitted to grow. It makes a valuable hay when cut at the beginning of the blooming season and does good service in enriching the soil. In the cotton field it must be kept under control by thorough cultivation or the seeds will become tangled in the cotton, but if allowed to spring up late in summer it will serve as a winter cover crop, to the great benefit of the land. The complete immunity of beggarweed to root-knot is an important point in its favor.

Resting land.—A practice common on the Sea Islands and in portions of Florida is to plant cotton alternately on half the farm, leaving the other half to grow up in grass and weeds. This is much better than continuous cotton planting, but is a defective system because the maximum capacity of the land is not obtained. It is better to grow a useful legume than coarse or obnoxious weeds, like fennel, coffeeweed, and sandspurs; or, if pasture is needed, rye may be sown between the cotton rows in the fall, grazed during the spring months, then plowed under and Iron[1] cowpeas sown for hay or for fall grazing. Thus, there may be substituted a 2-year rotation, which is perhaps the most practicable plan for the conditions now prevailing. The 2-year rotation in its simplest form is cotton on half the land and corn and Iron cowpeas on the other half, the cotton following the corn and peas each year. A better plan is to plant one-half of the land in cotton, one-fourth in corn and Iron cowpeas, and one-fourth in velvet beans, reversing the order so that velvet beans come on the same land once in four years, cotton twice, and corn and peas once. This is practically a 4-year rotation. If, after this has been repeated several times, the land becomes too rich in nitrogen, as indicated by an excessive growth of the cotton to weed, the velvet beans can be omitted for a year or two. Velvet beans or cowpeas in these rotations should be fertilized with about 200 pounds of acid phosphate and potash to the acre. No nitrogen is required.

A 3-year rotation is better than one of two years. The 3-year rotation for the first year might consist of rye, oats, or wheat for hay, followed by Iron cowpeas; second year, corn with Iron cowpeas; third year, cotton. Cut the corn when ripe and shred the stalks. Do not waste time pulling fodder. Cut the peas for hay or pasture them. In early fall plow under the stubble and sow rye, oats, or wheat. This grain should be cut for hay just before it ripens and should be off in time to plant velvet beans, if they are preferred to cowpeas. The field should be grazed during the fall and the remaining litter plowed in early enough in the winter to decay before the cotton is planted. The advantage of the 3-year rotation is that it permits keeping more live stock and will consequently improve the land more rapidly.

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[1] Brabham cowpeas may be used instead of Iron, if preferred. No other available varieties are resistant to root-knot.

FERTILIZERS FOR SEA ISLAND COTTON.

PRESENT PRACTICES.

The character of the fertilizers and the amounts used per acre by farmers in different parts of the Sea Island cotton belt vary between wide extremes. The practices on the Sea Islands are characterized by heavy applications of home-mixed fertilizers, differing considerably in composition according to the ideas of the various planters, but usually rich in potash. The need for humus is recognized and is supplied by growing cowpeas and by heavy applications of marsh mud, salt-water grass, and compost. Three typical examples follow: (1) Two hundred pounds of kainit, 200 pounds of acid phosphate, 400 pounds of cottonseed meal, 25 bushels of Sea Island cotton seed, 25 loads of marsh mud per acre; (2) 200 pounds of kainit, 200 pounds of acid phosphate, 200 pounds of lime, 1,000 pounds of Sea Island cotton seed per acre; (3) 300 pounds of kainit, 300 pounds of acid phosphate, 300 pounds of cottonseed meal per acre.

In Georgia and Florida, on the other hand, light applications predominate. Occasionally, however, a farmer goes to the other extreme and puts on 1,000 to 2,000 pounds of fertilizer per acre. A common practice is to use a complete fertilizer of the 2–8–2 grade,[1] applying 100 to 250 pounds per acre. Some planters, however, use only acid phosphate and potash, while others use nothing but kainit.

GENERAL PRINCIPLES GOVERNING THE USE OF FERTILIZERS.

The fertilizer question is too complex to discuss fully here. Farmers' Bulletin 44 contains detailed information on this subject, and will be sent free of charge to any person requesting it. A few general rules to be remembered are the following:

(1) The best results from the use of fertilizers can be had only when the soil has been put in first-class physical condition by deep plowing and the addition of vegetable matter.

(2) Stable manure and compost made on the farm are cheaper and far more effective and lasting than commercial fertilizers.

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[1] This means that the fertilizer contains 2 per cent of ammonia, 8 per cent of phosphoric acid, and 2 per cent of potash.

(3) The market value of commercial fertilizers is based on the nitrogen, potassium, and phosphorus they contain. The farmer should buy only the quantity of each element that will give the most profit on his soil.

(4) The amount of each element required varies with the soil so much that two sides of the same field often require different fertilizing.

(5) The proper fertilizer formula can not be told from a chemical analysis of the soil or of the plant, but an opinion can be formed from the appearance of the crop and verified by field trials.

(6) More plant food can be purchased for a given sum in high-grade fertilizers than in low-grade brands. Buy the best and use less per acre.

EFFECT OF NITROGEN.

Sea Island cotton requires less nitrogen than most crops, especially on low or moist soils. All excess of this element stimulates vegetative development, resulting in tall, coarse, and relatively unproductive plants, with large dark-green leaves. A lack of nitrogen is shown when plants are small, with a light yellowish green cast of foliage.

The usual sources of nitrogen, or ammonia, are cottonseed meal, dried blood, tankage, fish scrap, nitrate of soda, and sulphate of ammonia. It is the most expensive ingredient of fertilizers, costing 16 to 18 cents per pound, as compared with 4 to 5 cents for potash[1] and phosphoric acid, and for that reason should be supplied mainly by rotation with legumes. The effect of cowpea or velvet-bean stubble plowed under at the Alabama Agricultural Experiment Station was to increase the next year's cotton crop 63 per cent, this figure being the average of four tests. In such cases it is often unnecessary to purchase nitrogen, except that it may be profitable to apply about 50 pounds of nitrate of soda before planting, to stimulate the young seedlings to rapid growth. When commercial fertilizers are relied on the nitrogen is best derived from cottonseed meal or other organic materials, such as tankage or dried blood, which become available more slowly and are most lasting in their effects than the quickly soluble nitrate of soda or sulphate of ammonia. An exception should be made in the case of land subject to the blue disease, as stable manure or other organic fertilizers, unless very thoroughly decayed, aggravate this trouble. (See p. 40.)

EFFECT OF POTASSIUM.

A liberal supply of potash is very important for Sea Island cotton, and farmers outside of the Sea Islands use too little of it. Potassium influences the formation of starches and sugars in the plant and appears to be indispensable for protein formation. A lack of it in the case of Sea Island cotton may lead to the appearance of so-called rust, a disease resulting from disordered nutrition. Fields or parts of fields known to be subject to rust should receive an additional application of potash in amounts varying in accordance with the severity of the disease (see page 39). Kainit is the most common source of potash, but as it contains only 12 per cent of potash it should be applied liberally. Muriate of potash containing 48 per cent of potash is more convenient, on account of its concentration, and is usually considered to be proportionately effective. Fifty pounds of muriate of potash per acre would thus be equivalent to 200 pounds of kainit.[1]

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[1] See footnote cn page 14.

EFFECT OF PHOSPHORUS.

This element in the form of phosphoric-acid compounds is indispensable to the Sea Island cotton plant for its general development, and especially for the seed and lint. Most soils are deficient in phosphorus, which is therefore an important ingredient of fertilizers. Acid phosphate is the usual source, and on account of its low price forms an unduly large proportion of the average fertilizer.

LIME USUALLY UNNECESSARY.

With the exception of occasional applications of marl on the Sea Islands, lime is not used by cotton growers, and there is little evidence that it would be profitable.

THE BEST FORMULA.

From the foregoing it will be understood that no fertilizer formula can be given that will fit all cases. The following is suggested, subject to modifications as the conditions vary: Nitrogen, 3 per cent; acid phosphate, 8 per cent; potash, 4 per cent. A ton of fertilizer having approximately this composition could be made from acid phosphate, 1,050 pounds; cottonseed meal, 750 pounds; nitrate of soda, 62 pounds; muriate of potash, 138 pounds. The potash should be increased on land subject to rust, and the nitrogen increased or diminished according to the size of weeds the land will produce.

QUANTITY TO USE.

The aim may well be to apply the maximum quantity of fertilizer that will return a sure profit. This will vary according to circumstances and can be determined only by experiments made on each farm. Two hundred pounds per acre is too little in almost every case, and if more than 1,000 pounds per acre are applied some of the fertilizer is likely to be wasted, particularly on thin land. The better the soil in tilth and the richer in humus the more fertilizer can be used to advantage or with profit.

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[1] While war prices prevail, growers are advised to omit potash, to use all available wood ashes, compost, stable manure, and green manure, and to practice deep plowing, constant cultivation, and thorough tillage.

METHODS OF APPLICATION.

Where less than 400 pounds of fertilizer per acre are used it is probably best to apply all in the drill at the time of planting. For larger quantities many farmers prefer to divide the application, putting part in at the time of planting and the remainder during cultivation in June.

PREPARATION OF THE LAND.

Thorough clearing of the land, including the removal of all stumps, is essential for the use of modern plows and cultivators. The next requirement is drainage. If the land is wet or subject to overflow, it must be drained. This can be done by open ditches, but tiles are better. Farmers' Bulletin 524, on this subject, will be sent upon request. Many planters on the Sea Islands have greatly increased the producing capacity of their fields by drainage and have also much reduced the danger of loss from excessive rains.

RIDGE CULTURE.

On the Sea Islands, cotton is invariably grown on ridges or beds 5 feet apart, as indicated in the accompanying diagram (fig. 4). The method of forming and handling these beds is briefly as follows: Beginning in January, the old stalks are broken down, the limbs and trash raked into the alleys, and the coarser litter burned. In February, cotton seed is strewn in the alleys at the rate of 1,000 pounds to the acre, and a compost of stable manure, pine straw, marsh grass, and other refuse applied to as much of the field as the quantity obtainable permits, giving preference to the poorer portions. With a 2-horse plow a furrow is turned in from each side to cover the compost and seed. In late February or in March, the commercial fertilizer is drilled in at the rate of 600 to 1,000 pounds per acre and covered. The beds are rolled with a double roller (fig. 5) before planting. Strips of wood on these rollers mark the position of the hills. Planting is usually done by hand, sometimes with a planter. When the cotton is well up it is cultivated with a sweep and hoed by hand, the dirt being drawn around the plant. Cultivations and hoeings alternate. The cotton is worked every week—eight to ten times in all. Thinning begins when the plants are 5 to 6 inches high and is done gradually until only one plant is left in a hill. The cotton is laid by in July or August, when it becomes too large to work without injury. The plants are then growing on broad beds separated by alleys about a foot deep.

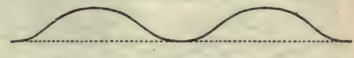
FIG. 4.—Diagram showing the ridge method of culture practiced on the Sea Islands.

While level culture is generally practiced in Georgia and Florida at the present time, it is quite likely that a modification of the South

Carolina broad bed would be more profitable. This ridge system gives better results in two classes of cases, as follows:

(1) On low and poorly drained land, where it permits greater root development on account of the improved aeration of the soil.

(2) When, on account of the land being rich and well fertilized, Sea Island cotton grows too much to weed under level culture. In such cases the grower is compelled to adopt measures to turn the energies of the plant from vegetative growth to fruiting. This is done by restricting the root development, (1) by maintaining a compact subsoil, which the Sea Island planters accomplish on their deep sandy soils by pasturing with cattle during the year of rest; (2) by regulating the moisture supply by the high beds, and (3) by root pruning by deep cultivation if the cotton needs it. It is also believed by the Sea Island planters that ridge culture permits better control of nut-grass, as this pest can be kept down more successfully by covering it with earth than by cutting it up.

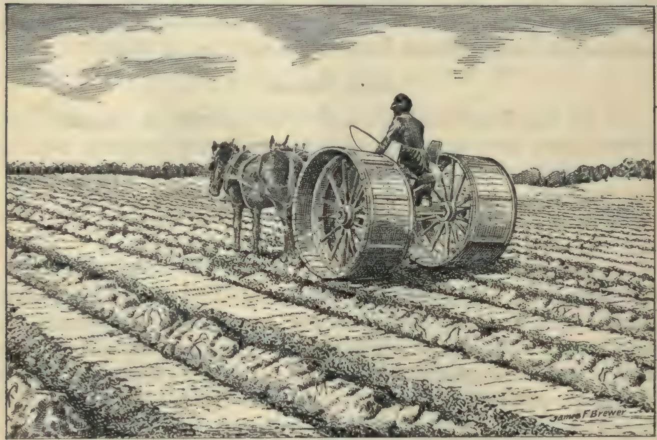

FIG. 5.—Double roller used on the Sea Islands, showing strips of wood used to mark the location of the hills.

The ridge system has its limitations and disadvantages, which must be borne in mind. It will not do for light and droughty soils deficient in vegetable matter and scantily fertilized, where the cotton plants would suffer from lack of moisture. Such soils should first be built up by a course of green manuring. The greatest disadvantage of the ridge system is the increased cost of cultivation due to the hand labor required to draw the earth around the plants. This objection can and must be met by the introduction of improved implements for cultivating which will work the beds without hand labor.

Interior farmers are advised to test the ridge method thoroughly after carefully studying the subject and adapting it to their conditions.

LEVEL CULTURE.

If level culture is preferred, the following instructions will apply.

PLOWING SHOULD BE DEEP.

It is advised that the land be broken broadcast with a 2-horse plow, 6 to 8 inches deep or as deep as practicable under the circumstances. In very shallow soils only an inch or so of the subsoil should be turned up at once, but by plowing an inch deeper each year such a soil can be deepened. Subsoiling has its advocates and may be profitable in some cases, but for the average Sea Island soil it is not recommended. If practiced at all, it should be for the corn or other crop preceding cotton in the rotation.

VEGETABLE MATTER SHOULD BE PLOWED IN.

All vegetable matter on the land and all that can be put on it should be plowed under in early winter, when it will have time to decay. The remains of a velvet-bean crop, or grass, weeds, cornstalks, etc., all greatly improve the land.

The common practice of burning over land before plowing can not be too strongly condemned. It means the deliberate destruction of fertility worth more than the farmer can afford to purchase and the loss of the humus that should be conserved by every possible means. An exception to this rule should be made if boll-rot or black-arm has been troublesome. Diseased stalks should be burned to prevent the infection of the next crop.

FERTILIZING AND BEDDING.

Having broken the land broadcast, apply the fertilizer with a fertilizer distributor in drills the proper distance apart. Bed over this with a disk harrow or with plows in the usual way.

PLANTING.

Plant with a good machine, preferably one that will drop the seed in hills at the desired distance, and thus save labor in chopping to a stand. A good distance for average conditions is 20 inches apart in 5-foot rows. The plants should finally be thinned to one in a hill. It is very difficult to judge the plants properly when selecting seed if two plants grow in the same hill.

Time of planting.—It is advised that planting be begun as early as the season permits. This varies in different years and sections from March 15 to April 10. Early-planted Sea Island cotton is found to make a more compact and fruitful plant, while late cotton tends to form a larger and coarser weed.

Long experience is required to judge truly the best time for planting, for the southern spring is variable and uncertain. On the one hand the cotton must escape frost, and on the other the spring droughts. Should dry weather prevail before planting is completed, the seed should not be put into the ground until there is ample moisture to bring it up, as otherwise it is likely to perish. Soon after the cotton comes up replant all missing hills. Every effort must be made to obtain a perfect stand. Every missing hill reduces the crop, while the cost of cultivation is the same as for a full stand.

CULTIVATION.

With level culture a weeder can be used to advantage for the first cultivation and at weekly intervals until the plants are too large. It must be used frequently, as it will not eradicate large weeds. Cultivation in general should be frequent and shallow. Cultivate deep only when the cotton is growing too fast and it is desired to stimulate fruiting. Economize labor by using cultivators rather than sweeps. Work the land as soon as dry enough after each rain, aiming to preserve a shallow dust mulch to conserve moisture. Never plow or cultivate when the land is wet. Lay by the cotton only when it is too large to cultivate without injury.

SEED SELECTION.

The high quality of Sea Island cotton to-day is due to the careful seed selection that has long been practiced on the Carolina Sea Islands. Seed selection is therefore a feature of prime importance, the keystone of the arch. The cotton plant has become variable, enabling the breeder to select finer forms and to raise the standard of the crop far above its natural level. By reason of this variability seed selection must be continued to prevent deterioration, for there is no standing still. The upward movement must be continued by perpetuating the finer types desired by the cultivator, or, if neglected, the inferior plants will increase rapidly in the crop and the cotton will tend to revert to its original type.

This constant seed selection is as necessary on the Sea Islands as in the interior.

SEA ISLAND METHODS.

There has been developed on the Sea Islands a well-defined and uniform system of selection. It is based on the correct idea—that of discovering the best individual plant and preserving its offspring. A number of superior plants are marked and carefully compared in the field, then picked separately and the seed cotton critically examined. The best plant is retained and the seeds planted in a plat by themselves, one or two in a hill, making perhaps 500 plants in all.

If this plat retains the good qualities of the parent plant, the cotton is picked and the seed again planted separately, making a 5-acre plat the third year. The fourth year there will be seed enough to plant the whole crop, all descended from the single stalk first chosen. A new individual plant is selected every year, so that a fresh supply of seed is always being grown. Seed from the general crop is considered less desirable for planting at home and was formerly sold to Georgia or Florida growers. A more effective method is to select and compare the progeny of several selections, as advised on page 22.

SEA ISLAND VARIETIES.

A number of planters on the Sea Islands have been practicing this system of seed selection for many years. Each man has his own ideals respecting the best form of plant and the most profitable length of staple and selects a type conforming most closely to this ideal. There have thus been developed a number of distinct varieties of Sea Island cotton which differ in length and quality of staple, form of plant, size and appearance of seed, percentage of lint, and other features. They are not given varietal names as much as in the case of other cultivated crops, but when offered for sale are known by the name of the breeder, as Hinson, Seabrook, Rivers, Sosnowski, etc. These names have not been preserved when seed has been sold to interior points, and there is consequently much confusion in the matter of varietal names.

Varieties of Sea Island cotton are constantly changing. Each breeder renews his stock annually and in doing so may propagate from a plant differing from his old type, in which case his entire crop four years hence would be influenced.

Breeders' rights.—Many of the Sea Island varieties, particularly the finer ones, are considered the personal property of the originator, who will not part with any of his seed, even to his neighbors. To do so would be likely to result in an overproduction of that particular staple and a lowering of prices, as the market demand for the higher priced staples is exceedingly limited. A strain of fine cotton is the product of many years of careful selection and could not be duplicated without long-continued work requiring much skill and care.

Sale of seed from the Sea Islands.—On the Sea Islands the growers of medium staples, for which there is a larger market than for the finer product, have for many years sold their seed, both at home and to buyers in Georgia, Florida, and foreign countries. In 1904, however, West Indian competition stimulated the formation of an association to prevent the sale of seed outside the Sea Islands. This embargo did not accomplish the desired aim, and the association has disbanded. It is greatly to be desired that the skilled breeders of the Carolina islands should select and grow for sale to the interior growers strains of suitable staple, about 1⅝ inches, to meet their requirements. Georgia and Florida, which have always depended on Sea Island seed, produce 90 per cent of the American crop, but because of the total neglect of seed selection, deterioration has been rapid there, necessitating the renewal of seed every few years.

SEED SELECTION WILL SUCCEED IN THE INTERIOR.

Thrown on their own resources, the interior growers have found that they can grow their own seed and maintain a satisfactory quality. The success of the Carolina planters is due to their methods more than to their soil and climate. There are already men in Georgia and Florida who have maintained the quality of their cotton for 15 years or more by selection without renewal from the Sea Islands. In fact, it should be possible to produce a variety better fitted for interior conditions than any imported seed, for adaptation to climate and soil can be secured together with greater productiveness.

METHODS OF SELECTION.

The amount of gain from seed selection will depend mainly on the method employed; the more care taken, the better will be the results. If any farmer is so situated that he can not select his own seed, let him at least obtain seed for planting from the middle picking in a field of known good quality or purchase from some near-by seed breeder. He should not risk an entire season's labor by planting seed of unknown value taken at random from a public gin.

Three methods of selection will be described. Under varying circumstances, all of them may well be employed.

ROGUING.

The simplest method of selection is called "roguing," because it involves merely the removal of inferior or varying plants, called "rogues" by seedsmen. This practice will serve to lessen deterioration in a variety already of satisfactory quality, but will not effect any material improvement. Every grower of Sea Island cotton should destroy all hybrid and run-out stalks whenever observed. The hybrid plants are the results of crossing between Sea Island and Upland varieties, or between Sea Island and other hybrids. They are the tall stalks, often called "male stalks" or "bull cotton," which are quite common in the average interior field. They do harm in three ways: (1) On account of their great size and vigor, one of them takes up as much room in the field as two good plants; (2) they bear a scanty crop, which is so inferior that it reduces the price of the whole crop when detected in the sample; (3) every seed from one of these plants produces a hybrid plant the following year; and (4) they hybridize with near-by plants and thus cause rapid deterioration of the quality of the crop.

Run-out plants are Sea Island stalks which have deteriorated until the staple is short and too scanty to cover the seed. (Fig. 6.) They can not be detected until the bolls begin to open, when it is best to pull them out, as the crop they will bear has no value and only lowers the quality of the rest of the crop.

GENERAL SELECTION.

A simple method of improving seed is to pick from the best plants in the field enough to plant the next crop, or to select with still more care a smaller quantity to plant a seed plat of 3 or 4 acres to grow seed for the general planting the following year. The selection of the seed is best done by the farmer himself, assisted by two careful pickers. Select from the middle picking before the main crop is gathered. Search through the whole field for the best and most productive plants. Before directing the pickers to pick a plant, examine the staple and reject every plant with lint less than 1⅝ inches long. It would be a vital error to select without regard for length of staple, because plants with wide-opening bolls would then be chosen and this quality is often accompanied by a short staple. Gin this selected cotton separately on a clean gin.

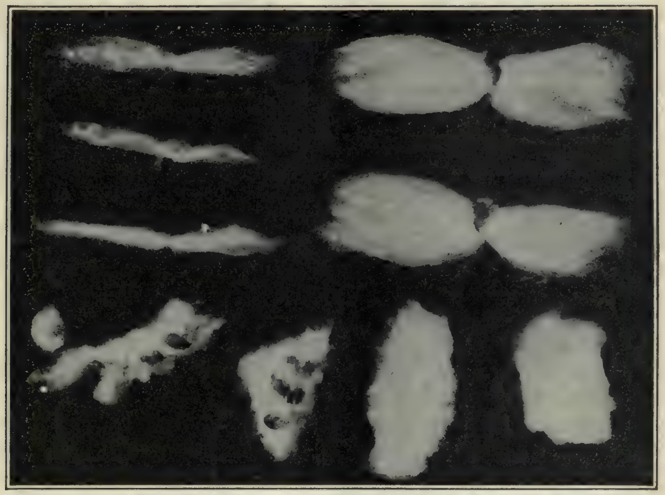

FIG. 6.—Good seed cotton (at the right) compared with a run-out form (at the left). The lower figures are the locks as picked. The upper figures are seeds with the fibers straightened out.

This method of selection can easily be followed by every farmer and will produce good results, but it is by no means as effective as the next plan described.

PEDIGREE BREEDING.

Pedigree breeding, while requiring more careful attention than the methods already described, will effect the greatest improvement in the least time and should be followed by all who undertake the production of improved seed for sale. It is substantially the same as the plan followed by the planters on the Carolina Sea Islands, where no other method would maintain such a high quality. All progressive farmers would profit by adopting this system.

The fundamental principle is to breed from a single plant of exceptional merit, which must also prove its ability to transmit its good qualities through its seed to its progeny. Instead of planting mixed seed taken from a large number of good plants, as in the preceding method, the choice is narrowed first to a few plants which are compared not only as to productiveness, length and quality of staple, etc., but also with regard to their prepotency and the uniformity of their offspring, as determined by a planting test the following year, until finally the progeny of the best individual is chosen. The seed thus obtained is increased as rapidly as possible until enough is secured to plant the whole crop.

A similar method is practiced by successful breeders of other crops, as, for example, in the ear-to-row plan of improving corn now so generally followed in this country. Plant breeders agree that too much stress can not be laid on the importance of searching for the exceptional individuals that may have great potential value for crop improvement. The best varieties of all our cultivated crops whose history is known came originally from a single plant or tree of unusual merit discovered by some observing grower.

Beginning the selection.—The first essential for selection is the formulation of the ideal type, toward which all subsequent work should be directed. It is assumed that the farmer who desires to improve his cotton has already planted a field from the best obtainable seed and has pulled out all objectionable hybrid or run-out stalks. He should begin to make selections as soon as the first bolls open. Choose the plants having a long staple and in other respects conforming to the ideals described. Mark these plants with a white cloth and a tag bearing a number. It is advisable also to set a tall stake by each selected plant, so that it can be found more readily. Pick each separately and at the end of the season spread on a table and compare the various lots critically and at leisure with regard both for length and fineness of staple and for yield. Discard the inferior ones until from 10 to 25 are left. These are to be further tested by planting the second year to discover the prepotency or transmitting power of each.

Second year: The progeny test.—Plant the seeds from the selected plants in adjoining rows, keeping each lot separate. These small lots can be planted in the lint, provided care is taken not to cover them very deep. Select ground adapted to cotton and have it well prepared. Plant with care, dropping only two seeds to the hill, and later thin to one plant. If possible, have 100 hills to the row. The location should be as far from other cotton as possible, to lessen the crossing. Isolation can usually be secured by planting the seed plat in the section of the farm used that year for other crops—in the middle of a cornfield, for instance. If it is necessary to plant near other cotton, plant a wide border of the same variety around the breeding plat. By all means avoid proximity to Upland cotton, which is the most serious factor in the deterioration of Sea Island cotton.

The object of this planting is to determine the relative merit of the different selections, and particularly their uniformity. The general excellence of the plants in each row should be considered—their vigor, productiveness, and freedom from disease. Any row lacking uniformity to a marked degree should be eliminated from consideration. When the bolls open, compare the staple, length, fineness, and uniformity, and finally choose the row possessing the greatest merit. This is to be the beginning of the new strain. In this row mark and pick separately the best 10 plants. (Fig. 7.) Pick together the remaining plants in the row. The other rows in the plat, although not retained for breeding, will be better than unselected seed and may be used for planting the general crop.

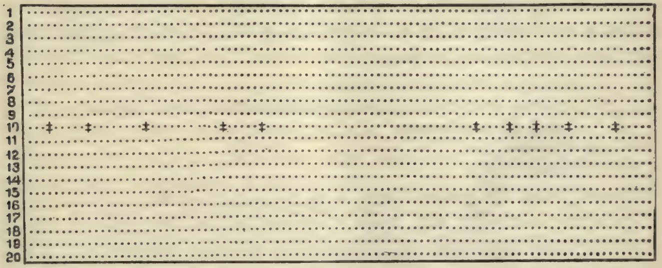

FIG. 7.—Diagram of pedigree breeding plats.

The desirability of this method of breeding will not be appreciated until it has been tried and the variations in the offspring of different plants observed. It is common to find one row with plants all alike possessing a staple longer than the average and also more productive, while another row may be widely variable in form of plant and quality of staple. Plants of superior merit often appear in the variable rows. They should not be saved, however, as the chances are that their offspring will be variable like the row in which they appear.

Third year: The increase plat.—The seed from the best row of the second year is to be planted in a small field to produce seed for planting the general crop. Any inferior plants that chance to appear in this field should be destroyed, but no other selection need be practiced, as it is not intended to plant this strain permanently, but to renew the seed annually from a new increase plat.

In addition to the increase plat, the progeny test is to be repeated, using the 10 plants chosen from the best row. Selections of exceptional merit that may be discovered in the general field should be tested in an isolated progeny plat, to avoid crossing with the select strain. Select in the same manner as before the best row and the best plants therein.

Fourth year: The general crop.—In this year and each succeeding year the same process of selection is carried out. This should become a part of the regular farm practice, to be considered of equal importance with cultivating and fertilizing. The several stages under way from now on are as follows:

(1) Selection of the finest plants.
(2) Progeny row test to determine transmitting power, uniformity, and productiveness.
(3) Increase plat.
(4) General crop.

If seed from the general crop is to be sold, careful attention must be paid to removing tall hybrid or run-out stalks from the field whenever they are observed. Seed from the last picking had better be rejected, as the upper bolls do not mature their seed as well as the lower ones.

Separate ginning of the seed crop important.—Cotton from the breeding plats or from other fields intended for seed should be ginned separately and the gin and conveyors first thoroughly cleaned of foreign seed. The farmer should personally superintend the ginning of his selected seed, as a mistake at this stage might lose him the fruits of several years' work. Owners of ginneries should realize their opportunities and obligations in this direction and afford their patrons every facility for the separate ginning of selected seed cotton.

The sale of cotton in the seed is a hindrance to seed improvement unless there is at the same time an organized movement for the distribution or sale of improved seed to the farmers.

IMPROVEMENT OF COTTON SEED BY GRAVITY SEPARATION.

It has been found possible to secure a marked gain in the percentage of germination and the vigor and productiveness of the cotton crop by removing the light-weight and imperfect seed before planting. For example, in an experiment by the writer the heavy seed germinated 27 per cent better than unselected seed and 42 per cent better than light seed thrown out by an air blast.

The separation is effected by means of an air blast produced by a fanning mill modified for the purpose. All who handle considerable quantities of Sea Island cotton seed will find it profitable to use such an apparatus. Seed from which the unginned locks and tufted seeds have thus been removed is much better adapted for use in cotton planters. Another very important gain in this process is the removal of the fuzzy seeds of Upland hybrids, which on account of their greater surface are blown out with the light seed. All ginneries should be equipped to treat in this way seed intended for planting.

IDEAL QUALITIES OF SEA ISLAND COTTON.

LENGTH OF STAPLE.

In Georgia and Florida the breeder should work for a staple not less than 1⅝ inches or more than 1¾ inches in length. In South Carolina each planter is guided by his own preferences, some planters choosing the medium kinds on account of their greater productiveness and others finding it profitable to grow the extra fine and long varieties. Experience has shown, however, that these fine strains, having a staple 2 inches to 2½ inches long and selling from the Sea Islands at 40 to 60 cents per pound, are not profitable in the interior. As compared with the medium sorts, they are less productive and more subject to disease, while the bolls are smaller and the cotton harder to pick. The fine staple requires more care in handling than the interior farmers are accustomed to give, and the interior markets will not pay as high prices as Charleston. In the past the best results in the interior have been obtained with strains classed on the Sea Islands as medium fine, such as Hinson and Seabrook.

To determine the length of staple from a sample of seed cotton, pull a lock apart and take a single seed and carefully straighten out the fibers with the fingers or a fine comb. Measure the length of the greatest number of fibers; then test several other seeds from the same plant.

UNIFORMITY OF STAPLE.

After determining the length, estimate the amount of shorter staple in the sample and discard plants having a portion of their staple either very long or too short. Uniformity is an important quality, as the spinner can not utilize the short fibers, which are combed out as waste.

STRENGTH OF STAPLE.

Pull a tuft of fibers until it breaks. Diseased plants show a marked weakness, and some healthy ones produce a weak staple and should be discarded.

PERCENTAGE OF LINT TO SEED.

This quality, or the "ginning average," is important, but farmers often lay too much emphasis on it, forgetting that it is the total yield of lint per acre that determines their profit.

The percentage of lint should be determined by ginning and weighing both lint and seed. The result is usually expressed in terms of the amount of seed cotton required to produce 1 pound of lint. To determine this, divide the weight of seed cotton by the weight of lint. To express the same in a percentage, divide the weight of lint by the weight of seed cotton. Having the ginning rate, to reduce it to a percentage basis, divide 1 by it; for example, 3.33=30 per cent. The percentage of lint varies considerably in different varieties of cotton, from 25 per cent, or 1 to 4, in extra-fine Sea Island cottons to 39 per cent, or 1 to 2.56, in small-seeded Upland cotton. It varies among plants in the same field, and there is a marked variation in different seasons, the percentage of lint being higher in favorable seasons. Even with the same variety and the same season, differences in soil and culture influence the percentage of lint. For example, a consignment of Seabrook seed was divided among several farmers in 1904. The ginning rates of the different crops produced from this seed varied from 3.96, or 25 per cent, to 3.10, or 32 per cent, the average of 41 fields being 3.42, or 29 per cent.

COLOR OF STAPLE.

The staple should have a lustrous creamy tint in preference to a dead white. The color should be uniform, as mixtures of white and creamy cotton are not desired by the buyers.

FINENESS.

Fineness depends on the diameter of the fibers, which can be measured exactly only with a microscope. An excellent opinion can be formed from the feeling of the cotton, if not too dry. Fineness is a very important quality to the spinner.

PRODUCTIVENESS.

Next to length of staple, productiveness is the most important quality. In making selections a preliminary estimate can be made by the eye or by counting the bolls. Sea Island planters estimate that every 15 bolls per plant equals 100 pounds of lint per acre under ordinary conditions. In breeding, the principal weight should be placed upon the yield from the progeny rows the second year of the selection. Strains derived from different plants in the same field have been found to vary greatly in productiveness, and careful selection will greatly improve any variety in this respect.

FORM AND SIZE OF PLANT.

The plant should be compact, 4 to 6 feet high, with a strong central stalk and two to four well-fruited basal branches. Fruiting branches should occur at close intervals, 1 to 2 inches, and a habit of double bearing, or producing an axillary branch at each node, should be developed. All branches should be close jointed and bear a boll at every joint. (See fig. 8.)

BOLLS.

The bolls should be large, long, and well filled to the end, not tapering too abruptly. As a rule a long boll indicates a long staple and a short or obtuse boll a shorter staple. The number of locks should be four. The majority of Sea Island bolls have but three. More than four locks, even if obtainable, would not add to the yield or to the convenience of picking. The bolls should open well, as such bolls ripen their cotton better and are far easier to pick. In making selections do not choose wide-opening bolls without examining the staple, as a wide-opening boll is usually correlated with short staples. In respect to this character and to the number of locks, care should be taken to avoid plants resulting from chance crossing with Upland cotton. If the size of the involucre, or "square," could be reduced by breeding, there would be less trouble from bits of dry leaf in the cotton at picking time.

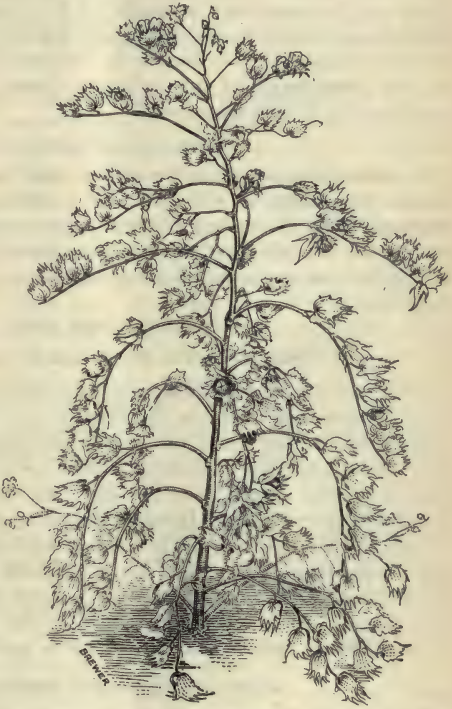

FIG. 8.—Ideal form of cotton plant. The leaves have been removed in order to show branching.

SEED.

The seed should be small, but well filled, black, with a small green tuft at the end. A large, perfectly bare seed is correlated with a low ginning rate and a large, coarse plant, and is usually taken as an indication that the strain is running out. An excess of short fuzz is characteristic of some Sea Island varieties, but such cotton can not be ginned as rapidly as other kinds. Large seeds entirely covered with white or green fuzz indicate hybridization with Upland cotton, but occasionally occur in pure Sea Island cotton.

EARLINESS.

Very early varieties are usually less productive than later ones, while very late ones may be caught by frost before fully mature. As the boll weevil invades the Sea Island districts, the breeding of early varieties apparently will become an important phase of the struggle for the preservation of this industry. Much earlier strains can be produced by skillful selection.

DISEASE RESISTANCE.

In some instances disease resistance may be a feature of fundamental importance, as when the land is infected with wilt. In such cases one of the disease-resistant varieties described on page 37 should be planted. In all selections attention should be paid to this point, particularly to secure resistance to black-arm and to anthracnose of the bolls.

HANDLING THE CROP.

PRESERVING THE FULL VALUE OF THE CROP.

After devoting his best energies for a whole season to the production of a fine crop of cotton, the farmer must still continue his vigilant oversight until the staple has left his hands. Sea Island cotton is a fine and delicate product, and there are many ways in which it may be injured and its value reduced. All defects in the cotton are ultimately charged to the farmer's account and reduce the price paid to him. If the spinner finds in a lot of Sea Island cotton 10 per cent more waste than in Egyptian cotton available for the same purpose, he will manifestly be unable to pay as much by 10 per cent for the Sea Island. By a little care much of the present waste can be avoided; hence, strict attention should be paid to these factors.

GRADE: DEFINITION AND IMPORTANCE.

In the cotton market the term "staple" refers to the length and fineness of the fiber, and these points are influenced most by seed selection. The term "grade," on the other hand, indicates the appearance of the cotton as regards cleanliness and color, qualities influenced mainly by the manner in which the cotton has been handled. The price is considerably influenced by the grade.

DEFECTS INFLUENCING GRADE.

(1) *Loss of bloom or luster.*—The best Sea Island staple has a gloss or luster which adds greatly to its beauty and is indispensable for certain kinds of fabrics. This bloom is destroyed by exposure to

sun and storm when cotton is left long unpicked, and the staple then has a gray, lifeless appearance, sometimes termed "mildewed" or "weather beaten." A similar effect is produced by picking cotton when wet with rain or dew and storing it in piles without first drying it in the sun.

To preserve the staple at its best, pick often—once a week, if possible—and expose the seed cotton to the sun to dry. This is done by spreading it in a shallow layer on a low roof or arbor, where it is turned frequently until so dry that the seed will crack between the teeth.

(2) *Loss of strength.*—The loss of luster is accompanied by a lessened strength, so that a staple originally good fails to make as strong thread as before—an added reason for better care. Very dry cotton is also not so strong as that which, under proper treatment, has retained its natural moisture.

(3) *Neps.*—The small matted knots which occur in cotton are designated as "neps" by spinners. They are difficult to remove in the process of spinning and often go into the thread and appear in the completed fabric as white dots. These neps are in reality tangles in the fibers, which when viewed under a microscope are seen to be weak and undeveloped. They are due in part to picking cotton before maturity; a boll that is forced open to extract the lint is a source of nep, as the cotton in it does not get the necessary exposure to the sun to dry and straighten and strengthen the fiber. Other nep originates with weak cotton from diseased bolls or from any other cause that prevents the fibers from attaining full development. Such undeveloped staple comes from the gin full of nep. Poor ginning, however, by weakening and breaking fibers increases the loss from this cause. Pickers should be cautioned against picking unripe bolls. Thorough sunning will in part remedy the trouble, and good culture, by producing healthy plants, will do more.

(4) *Broken leaves, etc.*—The presence of fragments of leaves, weed seeds, and other foreign matter in the cotton reduces its grade. These are often difficult to avoid, particularly after storms, when bits of the dried square, or involucre, are often mingled with the cotton; but pickers should be watched and cautioned against picking dirty cotton. Fortunately, the spinners find it easier to remove this class of impurities than the nep previously mentioned.

(5) *Short fibers.*—A large part of the waste is due to short fibers, which have to be combed out. They originate in part in variations in the length of the staple on the seed, a serious fault, to be remedied by seed selection, as discussed under uniformity (page 25). Short fibers are in other cases due to imperfect ginning, which breaks or crimps the staple and may be avoided by better adjustment of the gin.

(6) *Weak fibers.*—The greater part of the waste is due to the presence in the baled cotton of staple from undeveloped or diseased bolls. The bolls in such cases do not open, and the fibers do not expand but remain matted together in a "hard lock" (fig. 9). All locks that do not open out after drying may be assumed to be worthless on account of weak and undeveloped staple. Pickers should be instructed not to gather hard locks, and in the assorting after picking all remaining ones should be thrown out. Seed cotton still containing hard locks when it reaches the gin can be improved by setting the stripper bars well back from the roller to allow the locks to fall through. Close ginning is a mistake, for it costs the farmer more through deterioration of his cotton than he gains by the slight increase in weight.

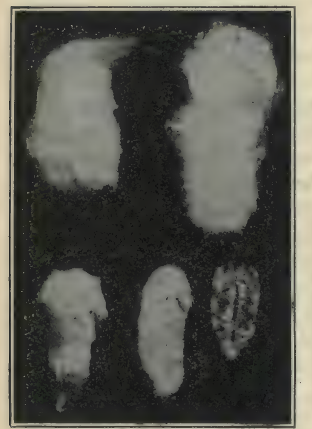
FIG. 9.—Locks of Sea Island cotton from healthy bolls (at the top) compared with hard locks from diseased bolls (below).

The number of hard locks can be greatly reduced by bringing the cotton to perfect maturity through attention to fertilization and culture and to the control of diseases.

(7) *Lack of uniformity in the bale.*—Separate late from early pickings. Buyers desire to have each bale uniform within itself. If, therefore, a late picking is inferior to an earlier one, it should not be ginned and packed with it, as the price of a bale is determined by the poorest cotton found in it after thorough sampling.

(8) *Yellow cotton.*—Buyers invariably complain when a sample of cotton contains yellow staple, and the grade and price are consequently reduced. Yellow tufts in the ginned cotton come from discolored locks that should have been left unpicked or sorted out before ginning. They originate, as a rule, in bolls attacked by the anthracnose or bacterial boll-rot (see page 39). Their presence in a bale is an indication of too close ginning.

(9) *Sand.*—A bale of cotton always contains considerable sand which has been blown into the open bolls. This is quite unavoidable, but when cotton has been left unpicked and has blown out on the ground the quantity of dirt is increased.

(10) *Moisture.*—An element of waste from the spinner's standpoint is the moisture which evaporates during the process of manufacture. This moisture may be excessive in cotton picked early in the season and ginned without drying. There may, on the other

hand, be a lack of moisture. The cotton may be overdry and appear harsh and brittle. Such cotton gives trouble in spinning because of the electric current it develops.

The question of moisture is one of the most important connected with the handling of cotton. Either an excess of moisture or a lack of it reduces the grade. The farmer must never add water to the cotton, but he should seek to retain the optimum amount of natural moisture. This means that to drive off excessive moisture freshly picked cotton should be sunned until the seeds will crack in the teeth. The staple will then be slightly overdry and unfit to gin or offer to the buyer. To restore its grade it should be "bulked." Bulking, as practiced on the Sea Islands, consists in placing the seed cotton, after sunning, in a large, deep, square pile in a cool room. It should be packed down solidly and, if the air is dry, covered with blankets or boards and left from three to six weeks before ginning. When it comes out of bulk the staple has lost its harsh feeling and is soft, oily, and glossy.

Care must be taken never to bulk cotton that has not previously been well dried, or the pile will heat. On the other hand, a loose, conical pile, formed by throwing seed cotton into a storeroom, is not a bulk, for it does not prevent the cotton from drying out still more. As a rule, cotton brought to the gins early in the season is too green and damp and needs sunning to put it into good condition, while that coming in late or taken from the storehouses during the winter is overdry and consequently harsh and brittle. Both the lint cotton and the thread spun from it lack their full strength if too dry. Everyone knows how a dry twig will snap in the fingers, while a green one only bends. The same to a less degree is true of the cotton fiber. The quality is best maintained, however, by avoiding overdrying rather than by the addition of moisture.

(11) *Injury in ginning.*—The grade of cotton is often reduced during the process of ginning. This may be the fault of the farmer, as when he brings his cotton to the gin damp or full of hard or yellow locks or broken leaves and insists on close ginning; or the fault may lie with the ginner, who has failed to adjust his machines so that no seed can be broken. Briefly stated, seed cotton must be dry; if green or wet, "crimping" invariably results, to the serious injury of the fiber. The seed cotton should be free from hard locks or else the stripper bar should be adjusted to let them fall through with the seed. Close ginning is a form of adulteration instantly detected by the buyer and very costly to the farmer. The modern fruit grower has learned that he can not profitably mix his culls with his first-grade fruit, and the cotton grower must come to a similar conclusion.

The most frequent defects due to ginning are the presence of portions of broken seed and the cutting or crimping of the fiber. Since poor ginning costs the farmer, at a conservative estimate, 1 cent a pound, the ginner should be required to maintain his gin in perfect adjustment and to gin the cotton free from cracked, clipped, mashed, or whole seed and free from crimp.

The ginned cotton should come from the roller steadily and in an unbroken flake. Whenever it does not do this, an examination will show that the adjustment is not perfect, and the cotton is liable to sustain injury unless the trouble is corrected.

SUMMARY.

The best practice in handling the crop may be briefly stated by describing the method followed on the Sea Islands, which should be adopted in the interior in so far as the labor conditions will permit.

Picking is done whenever enough cotton is open, about every 10 days. The cotton is gathered as free from trash as possible and carried to the storehouse, where the next morning each picker sorts his own picking, throwing out diseased or yellow locks and pieces of bolls, leaves, and other trash. The cotton is then spread on arbors to dry in the sun. It is watched and turned frequently, and usually dries in one day. After sunning, the seed cotton is assorted by women, who remove any yellow locks, bits of leaves, etc. If very dirty it is whipped over a coarse wire screen stretched across a small box to take out the sand. Very fine cotton is again sorted or overhauled by another set of laborers. The cotton is then bulked and allowed to remain from four to six weeks before ginning. During the ginning, one or two hands inspect the cotton as it passes to the gins, to remove impurities, and one of two others "mote" the lint as it passes from the gin to the press, by picking out yellow tufts, etc. By all these means a high grade is maintained for Sea Island cotton, which is reflected in a price per pound several cents higher than that paid for interior cotton.

DISEASES OF SEA ISLAND COTTON.

SORE-SHIN AND DAMPING-OFF.

Cotton seedlings sometimes become diseased shortly after coming up, particularly when soil or weather conditions are unfavorable. The term "sore-shin" is applicable to diseased spots or cankers formed on the stem or root of the seedling. These spots result in a reduction of growth, in yellow leaves, and, if they encircle the stem, in the death of the plant.

A fungus (Rhizoctonia) is usually held responsible for the trouble, but it is only after cold and wet weather has checked growth and weakened the plants that serious loss results. If warm and favorable weather prevails, the cotton soon outgrows the disease. No direct remedial measures are practicable. The danger of loss can be minimized by thorough preparation of the land before planting, by draining lower lying fields, and by thick seeding. Broken stands must be filled by replanting.

Damping-off, or the collapse of the stem at the surface of the ground, may be due to the sore-shin fungus or to other parasites. It is often caused by anthracnose, in which case the seed was probably infected before planting. The recommendations for the treatment of anthracnose on page 39 apply also to this form of it.

BACTERIAL BLIGHT.

There is a bacterial disease of cotton (*Bacterium malvacearum* Erw. Sm.) which is found to occur on different parts of the plant, producing various symptoms and receiving various names, such as angular leaf-spot, black-arm, boll-spot, etc., according to the point of attack. We describe all these together.

The earliest appearance of the disease is perhaps on the leaves, where it produces what is commonly known as the angular leaf-spot. These spots are at first a water-soaked green, becoming black when older. They are angular in outline, one-eighth to one-fourth inch in diameter. They are scattered over the leaf, but are often more numerous near the large veins. When one of these veins is attacked the disease rapidly extends its whole length.

Infection of the petiole is less common, but sometimes occurs, causing the leaf to turn yellow and fall off.

Infection of the pedicel of the bolls is a common cause of shedding and of failure to open. The bolls themselves are also attacked, the points of infection being water-soaked at first, later appearing considerably sunken and almost black. This organism does not appear to be as active a cause of boll-rot as the anthracnose fungus and several bacteria which appear to follow it, and which very likely gain entrance through the bacterial spot.

In June young plants are sometimes attacked on the main stem, near the ground or higher up, where a canker is formed which so weakens the stem that it is broken off later by winds or during cultivation. It is later in the summer that the most damage occurs, when the disease attacks the fruit-bearing limbs. The spots on the limbs are dark—nearly black—and, though not deep, so sap the vitality as to cause the shedding of all the smaller bolls. In many cases, when the season is wet, infection by anthracnose follows and adds to the injury. Several forms of the disease are illustrated in figure 10.

Egyptian cotton is peculiarly subject to this trouble—so much so that its cultivation in the Southeastern States appears to be impracticable. There is considerable variation in the resistance of different races of Sea Island cotton, Rivers, for instance, being rather susceptible, while Centerville is nearly immune.

Remedial measures must be indirect. Resistant varieties can be developed by selection. Diversification and rotation of crops will tend to reduce the amount of infectious material remaining on the land and will lessen the disease. Black-arm is probably carried through seed to some extent, and the selection of seed only from healthy bolls will greatly aid in its control. It may be expected that a reduction of the nitrogen and an increase in the amount of potash in the fertilizer, by inducing development of less succulent branches, will reduce the danger of infection.

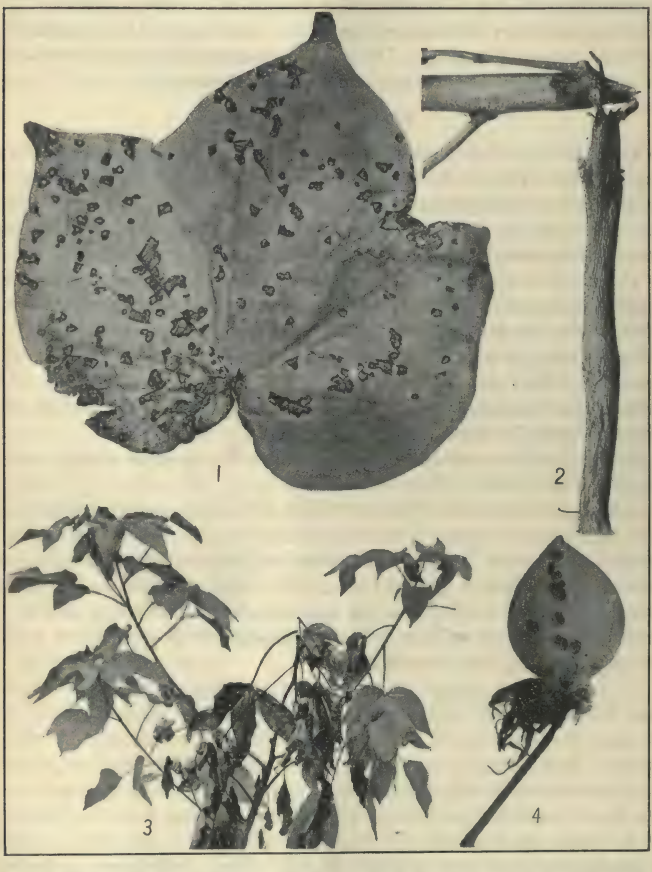

FIG. 10.—Diseased leaves, boll, and stems of cotton plants, showing several forms of bacterial blight: 1, Angular leaf-spot (Upland cotton); 2, black-arm (Egyptian cotton); 3, stem canker on a young Sea Island plant: 4, bacterial boll-rot (Upland cotton).

WILT.[1]

Cotton wilt, often called black-root, is one of the most serious diseases of the crop wherever it occurs. It is characterized by the death of the plants in gradually enlarging spots in the field, where the disease reappears year after year. The plants are attacked at any time after they are a month old, but die fastest in June and July. The affected plants wilt, or a few leaves at a time turn yellow between the veins and fall off. (Fig. 11.) When the stem or root is cut the woody portion is found to be brown or black. This discoloration is one of the most characteristic symptoms of the disease and has given it the name black-root.

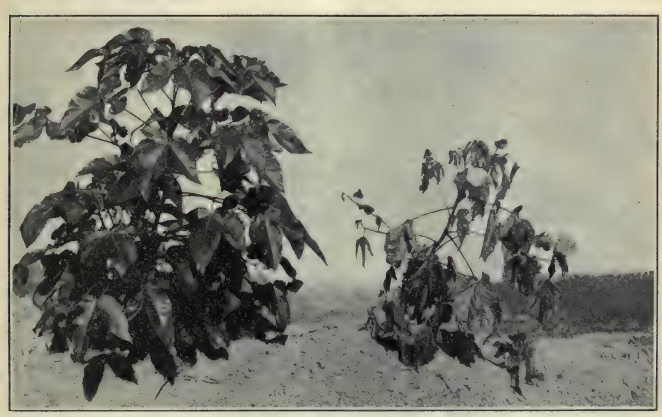

FIG. 11.—A healthy cotton plant and one affected with wilt.

Wilt is most prevalent on the sandy or sandy loam soils best suited for Sea Island cotton. Low spots and rich bottom lands often escape the disease long after the cotton on the higher portions of the field is killed. Clay soils are, as a rule, free from it. Geographically, wilt occurs more or less in all the Sea Island cotton-growing districts, both in South Carolina and in the interior. It is also serious in Upland cotton fields from North Carolina to Texas.

CAUSE.

Wilt is due to a fungus (*Fusarium vasinfectum* Atk.) which enters the small roots from the soil, grows into the water-carrying vessels of the root and stem, and fills them, thus shutting off the water supply of the plant.

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[1] See also Gilbert, W. W., Cotton wilt and root-knot, U. S. Dept. Agr., Farmers' Bul. 625, 21 p., 15 fig. 1914.

This fungus spreads by direct growth through the soil and also forms three kinds of spores, viz, one in the interior of the stem, another in cushions on the outside of dead plants, and a third in the soil or on the surface of the plant. This fungus is without doubt spread to some extent by the feet of stock passing through the fields, carried in drainage water from high to low land, and distributed by plows and cultivators. When it appears in a field, attempts to restrict its spread are useless, so far as the writer's knowledge goes. As wilt attacks only cotton and okra, good yields of corn and other crops can be obtained on infected land. A long period of rotation tends to diminish the amount of disease, but the fungus can live in the soil for several years, cases being on record where seven years' rest failed to free the land from wilt.

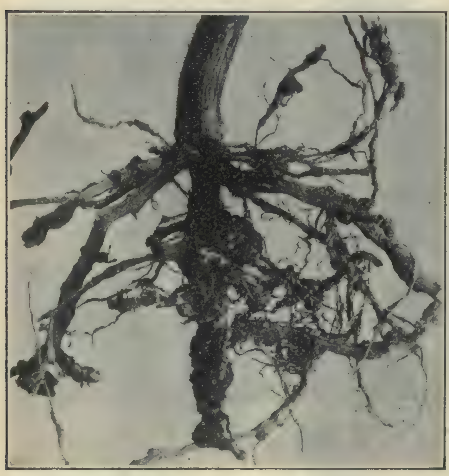

FIG. 12.—Root-knot on a cotton plant grown on land where nonresistant cowpeas were raised the previous year.

An important point in connection with the question of rotation is the danger from root-knot, another disease, described on page 38, which often occurs along with the wilt.

Enlargements of the roots of cotton (fig. 12) indicate that root-knot is present and that a rotation of crops must be practiced to control it. The combined treatment of wilt and root-knot is based on the following principles:

(1) Cotton wilt attacks only cotton and okra. It does not disappear after rest or rotation. Resistant varieties can be secured.

(2) Root-knot attacks cotton, cowpeas, sweet potatoes, vetch, melons, and many other crops, but does not attack corn, oats, velvet beans, or the common grasses. It diminishes and finally disappears when all susceptible plants are kept off the field, and in ordinary farm practice can be held in check by a suitable rotation of crops. No variety of cotton is wholly resistant to root-knot.

A rotation similar to the following should therefore be adopted: First year, corn with Iron or other resistant cowpeas, or peanuts; second year, winter oats, or, if preferred, rye or wheat cut early for hay and followed at once with velvet beans; third year, cotton of a wilt-resistant variety.

SOIL TREATMENT NOT A SUCCESSFUL REMEDY.

It has been found impossible to kill out the fungus in the soil by any treatment with fungicides. Experiments have been made with lime, sulphur, copper sulphate, formalin, carbolic acid, and numerous other substances, none of which had any effect in reducing the amount of wilt.

The fungus is so spread through the soil that it is unlikely that it can ever be killed by any treatment that would be cheap enough to be practicable.

THE RELATION OF SOIL CONDITIONS TO WILT.

It should be emphasized that wilt is due to the presence of a parasitic fungus, not to any unfavorable soil conditions. The fungus is, therefore, to be looked on as a weed, and the disease may be expected to appear wherever its spores are carried. There are no chemical or physical differences between wilt-infected and healthy soils of the same type. Wilt is not due to the continual use of commercial fertilizers nor to the exhaustion of any element of plant food. Its preference for light and sandy soils has already been noted. Our experiments indicate that the free use of stable manure will assist in the control of wilt by increasing the vigor of resistant varieties, but the ordinary nonresistant kinds are not sufficiently protected by stable manure. In the same way other organic fertilizers, such as compost and leguminous crops plowed under, will effect an improvement of the crop.

CONTROL THROUGH THE USE OF RESISTANT VARIETIES.

It has been found possible to secure by seed selection varieties of Sea Island cotton resistant to wilt which will yield full crops of good quality on badly infected land, provided there is not too much root-knot present also. They were developed on the Sea Islands by selecting seed from exceptional plants that withstood the disease and remained healthy in the most infected spots. The first and best of these varieties is the Rivers, bred by Mr. E. L. Rivers, of James Island, S. C., in connection with the experiments of the United States Department of Agriculture. The Rivers cotton is productive, vigorous, compact, branching low, and with small, close-jointed limbs, often double bearing; bolls medium size, three to four locks; seed small, black, with a small green tuft; average percentage of lint to seed 28, giving a ginning rate of 3.57; staple fully to extra fine, and when grown on the Sea Islands 2 inches long.

The Rivers cotton is an excellent variety for the Sea Islands and for the best localities in the interior, but has too long a staple to be adapted to interior requirements, although its total yield per acre compares favorably with any other. It has also shown some susceptibility to black-arm when cultivated in Georgia.

Other resistant strains have been developed by the South Carolina Sea Island growers, and very little loss from wilt now occurs there.

Farmers who have wilt-infected land should secure seed of a resistant variety or, failing in this, should plant some other crop than cotton on the disease-infected field.

Once a wilt-resistant variety is obtained, this quality of resistance should be maintained by the method of selection already described. Dependence can no longer be placed on the hope of obtaining seed from outside growers.

CONTROL THROUGH ORIGINATING NEW VARIETIES.

Anyone who will give the necessary time and care can develop new resistant strains from the resistant plants that occasionally appear in fields of ordinary cotton. He must be prepared, however, to continue the breeding for several years before the desired results are attained.

No one should gather seed promiscuously from an infected field with the idea of gradually developing a resistant variety, for such methods are costly and usually fail. Breed from individual plants instead.

ROOT-KNOT.

Root-knot is a common and widely distributed disease in sandy soils throughout the southern tier of States. The effect on the plant is to lessen its vigor and dwarf its size. The seat of the trouble is at the root, which becomes distorted and covered with small swellings or knots. (See fig. 12.) These are produced by a minute nematode worm (*Heterodera radicicola* [Greef.] Mül.) which penetrates the roots and lives within them. On breaking open a large knot, one can often detect minute pearllike bodies, which are the female worms distended by masses of eggs.

Root-knot is a more serious enemy of peaches, vegetables, tobacco, and cowpeas than of cotton. It becomes of great importance to the cotton planter when it occurs in connection with wilt, which it very often does, as the loss from cotton wilt is much increased by the root-knot complication. The treatment required is the rotation of crops that has already been discussed under wilt. The subject is treated more fully in Farmers' Bulletin 648.[1]

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[1] Bessey, E. A., and Byars, L. P. The control of root-knot. U. S. Dept. Agr., Farmers' Bul. 648, 19 p., 20 fig. 1915.

ANTHRACNOSE.[1]

The greater part of the loss from the rotting of bolls is due to the disease known as anthracnose. This occurs as dark-colored spots on the bolls, which as they enlarge become depressed and gray or pink in the center. (Fig. 13.) The seed cotton in the bolls is discolored and spoiled. The cause is a parasitic fungus (*Colletotrichum gossypii* Swth.) which is very common throughout the cotton belt. While most of the injury is done to the bolls, the fungus can attack any other part of the plant. The disease is worse in wet seasons than in dry ones.

REMEDIES.

No treatment of fields affected with anthracnose is practicable on account of the expense involved, but there are important preventive measures that will enable one to grow a healthy crop.

(1) Plant healthy seed. Where trouble from this disease is experienced, the seed for the next crop must be selected with care from perfectly healthy bolls. If a boll has one lock affected, there is danger that the fungus has penetrated all the seed. Avoid, if possible, running the selected seed cotton through a gin that has just been handling diseased cotton. All accessible parts of the machine should be wiped clean, to prevent the fungus spores from remaining to infect the selected seeds. It will not do as well to send away for seed from a healthy field, for the disease occurs everywhere. Seed 3 years old will also be safe to plant, as the fungus in it will then be dead.

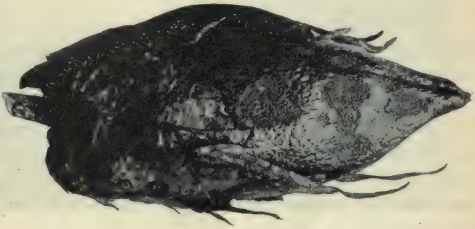

FIG. 13.—A cotton boll affected with anthracnose.

(2) Plant on land that was not in cotton the year before. Twelve months' rotation will rid the soil of infection.

RUST.

The disease commonly known as cotton rust is not primarily a fungous disease, but is caused by unfavorable soil conditions. Sea Island cotton fields affected by rust take on a reddish color, the leaves drop off, sometimes leaving the stalk bare, and the upper bolls fail to open. The cotton from such rusted plants is very weak and inferior. Rust is likely to develop in definite spots in a field, and unless a remedy is applied will appear year after year. Though other factors sometimes influence particular cases, there are three principal causes of rust in cotton, as follows:

(1) Exhaustion of the humus. Continued cultivation in cotton, by destroying the vegetable matter of the soil, is the most frequent cause of rust. The color of

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[1] See also Gilbert, W. W., Cotton anthracnose and how to control it, U. S. Dept. Agr., Farmers' Bul. 555, 8 p., 8 fig. 1913.

these old fields in midsummer is a lighter green, with a tinge of yellow, followed when the bolls begin to mature by the appearance of rust. A newly cleared field or an old fence row is, on the other hand, always green and free from rust. Stable manure is the most effective remedy in such cases, but a crop of velvet beans or cowpeas plowed under will effect a great improvement.

(2) Deficiency of potash. Most soils where cotton shows a tendency to rust lack potash, and an application of 200 pounds of kainit or 50 pounds of muriate of potash per acre will prove an effective remedy. Such soils are, as a rule, also deficient in humus, and a rotation of crops is usually advisable also.

(3) Lack of drainage. Rust often develops in low, wet places in a field where the higher portions are free from it, and for the same reason heavy and continued rains in August and September may lead to the development of rust in certain fields. Drainage by ditching or by tiles will be required in extreme cases. Most of these fields, however, become stagnant because the soil has no water-absorbing capacity on account of its lack of humus. If a leguminous crop were turned under every other year or stable manure applied liberally and the land plowed deep, the soil would soon be so changed in condition that heavy rains would not injure it and rust would disappear.

BLUE COTTON.

Blue cotton is a peculiar disease which occurs to a limited extent on the Sea Islands and in Florida. It is characterized by the deep-green or bluish color of the leaves, the prostrate habit of the plant, which develops numerous lateral sprouts, and the shedding of the fruit. It is caused by some physiological or nutritional disturbance of the plant, due to soil conditions not fully understood. The use of cottonseed and other organic manures aggravates the trouble. It has been successfully remedied on the Sea Islands by the use of salt mud, by liming, and by drainage.

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Dup.

THE WINDBREAK AS A FARM ASSET

CARLOS G. BATES
Forest Examiner

FARMERS' BULLETIN 788
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Forest Service
HENRY S. GRAVES, Forester

Washington, D. C. **April, 1917**

WINDBREAKS are, in more ways than one, a farm asset. They tend to prevent the soil from drying out quickly and they protect grain and orchards from mechanical injury by the wind. A belt of trees by the farm buildings protects them from extreme winter cold and summer heat, and makes the farm a pleasanter place in which to live. The windbreak may also be a source of wood supply for use on the farm or for sale. This bulletin tells how windbreaks act and what returns may be expected from them in dollars and cents.

THE WINDBREAK AS A FARM ASSET.

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WINDBREAKS ON THE PRAIRIES.

WHEN the prairie regions of the Middle West[1] were first developed the lack of trees was felt severely. The clear sweep of the winds across the flat plains was a great hindrance to agriculture, for the soil was dried out quickly by evaporation, and grain was lodged and orchards injured by the mechanical force of the wind. Windbreaks were the only remedy, and thousands of miles of them were planted along roads and farm division lines. The effect of this planting, though only gradually felt, was very distinct; farming and living conditions became more favorable throughout the whole region.

Considerable planting is still being done, but probably no more than enough to counterbalance the cutting in windbreaks already planted. Of course the need of windbreaks is not so acute now as it has been in the past, but some extension of the planting in this region is desirable, at least enough to protect the new areas which have been put under cultivation.

WHAT IS A WINDBREAK?

Any body of trees which gives protection to buildings or crops may be called a windbreak. This bulletin has to do, however, only with belts of trees planted about fields and farm buildings, especially for the purpose of breaking the force of the wind. The typical windbreak is a belt consisting of from six to eight rows of trees and usually from a quarter of a mile to a mile in length.

HOW A WINDBREAK PROTECTS.

CHECKING WIND MOVEMENT.

The influence of a timber windbreak upon air currents is purely mechanical. Its effectiveness depends, therefore, upon how nearly impenetrable it is. The ordinary windbreak does not provide an absolute barrier to the wind; a certain amount of air forces its way between the branches and foliage of the trees, so that the movement of the air on the leeward side is not completely stopped but only greatly reduced. When windbreaks composed of such trees as cottonwood become old, wide openings are left between the bare trunks and more wind gets through near the ground than higher up.[1] Such windbreaks can be made efficient only by underplanting the cottonwood with other trees or shrubs.

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[1] The Middle West includes the States of Illinois, Iowa, Minnesota, Dakota, Nebraska, and Kansas.

An ideal windbreak for checking wind currents would have the contour of an earth dam. In the central rows would be planted the tallest trees, such as cottonwood; on either side, rows of shorter trees, such as ash and locust; and outside of these, low bushes or cedars. Such a windbreak would not be easily penetrated, and its inclined surface would divert the air currents upward and relieve the horizontal wind pressure.

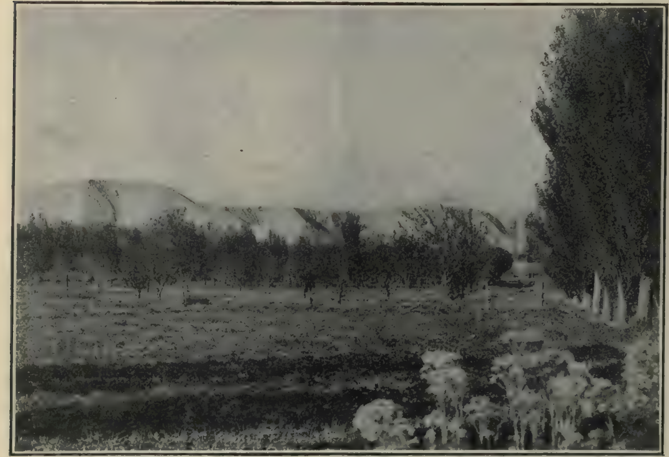

FIG. 1.—On irrigated lands in western Colorado (Mesa County), the Lombardy poplar, a close relative of the cottonwood, grows thriftily, and is used for the protection of orchards.

Breaking the mechanical force of the wind benefits the farmer most directly by protecting his grain crops and his orchard. The value of the windbreak in giving this protection is, of course, difficult to measure in dollars and cents, but where winds are at all frequent such protection alone may be equal to the rental of the ground occupied by the trees. In one case in southern Minnesota a windbreak,

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[1] A dense mulberry hedge of a single row may offer quite as much resistance to the wind near the ground as several rows of open-growing locust or cottonwood.

80 rods long and about 28 feet high along the side of a cornfield, afforded complete protection for a strip about 10 rods wide during a wind blowing at 50 miles an hour. On the unprotected part of the field the wind blew down half the corn and bent the remainder halfway, the damage beginning at the edge of the 10-rod strip and increasing until it was greatest in that part of the field farthest from the windbreak. The corn was in the milk stage at the time of the high wind and did not produce more than a third of a crop on the damaged area. On the protected portion the total saving was 260 bushels, or the full crop of 6 acres, whereas the windbreak occupied only 2 acres.

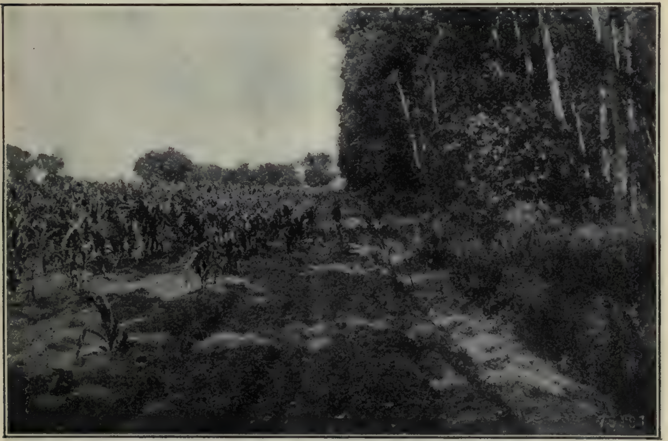

FIG. 2.—Corn to the north of a cottonwood grove is badly damaged by shade in a few rows adjacent to the trees.

Movement of the topsoil also may be checked and dust storms prevented by breaking the force of the wind. For this reason windbreaks are of immense benefit in sandy regions or regions where the soil is very fine.

Added to the crop and soil protection there is the personal comfort to be derived from protection from wind about the farm and home and along public roads. Furthermore, a protected home is heated in winter more readily, and hence more cheaply, than one exposed to the wind.

REDUCING EVAPORATION.

There is no part of the United States, except small areas in the Appalachian and Cascade Mountains, which normally obtains more precipitation than is needed for growing the best crops. The farmer usually plows, cultivates, and mulches with the object of conserving every drop of water that may reach the soil during the year. In the "dry-farming" regions of the West these conservation measures are carried farthest. Here it may be necessary to save the moisture of two seasons to grow a single crop.

Anything which helps to conserve the moisture of the soil is of direct benefit to the farmer. The windbreak has this effect in a marked degree. The drying power of the wind is reduced by the windbreak very nearly in the same proportion as its velocity. In the immediate lee of the most effective windbreaks evaporation is reduced as much as 65 per cent. Farther from the trees the reduction is less. The amount of reduction depends not only upon the density and proximity of the windbreak, but upon whether the field is fallow or in crops. The saving in moisture is least when the field is fallow, so that the only reduction is in the direct evaporation from the soil; it is greatest when the field is in crops, so that there is a reduction not only in the direct evaporation from the soil but also in the evaporation from the leaves of the crops.

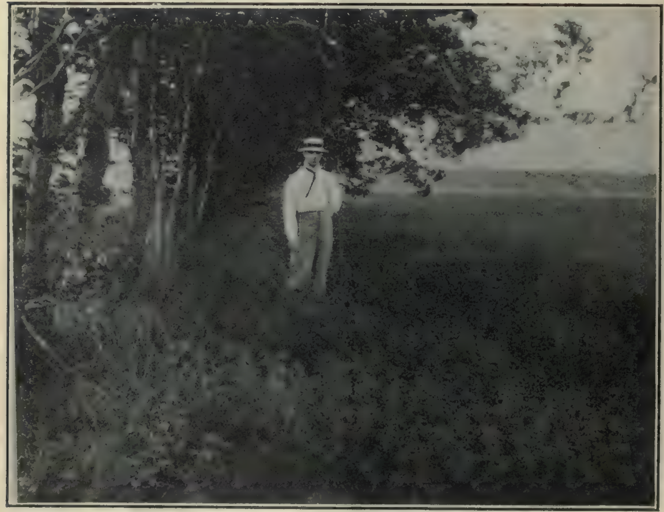

FIG. 3.—Alfalfa grows almost to the base of honey-locust trees.

The more frequently winds occur in any locality during the growing season, and the greater their velocity and drying power, the more important it is to use every means of preventing evaporation. Windbreaks are especially valuable, therefore, in the Middle West, where hot, dry winds, often of high velocity, are of frequent occurrence during the summer months, and in Montana and the Dakotas, where the warm west winds of the winter and early spring, known as "chinooks," do great damage to winter wheat and orchards.

EFFECT ON TEMPERATURE.

The farmer who has cultivated crops on a hot summer day need hardly be told that the warmest part of his field is the portion which is sheltered from the wind. In the lee of the windbreak there is not only no breeze to cool the body and reduce what is known as the "sensible temperature," but the actual temperature of the air is raised. Tests with a thermometer have shown that the area which is protected by a windbreak may be several degrees warmer during the day and several degrees cooler during the night than adjacent areas not protected.

FIG. 4.—The branches of ash are small and short, and the tree does little damage by shading crops.

Such crops as corn are benefited very greatly by warm, sultry days. The windbreak helps to create these conditions and offsets to some extent the effect of cold, cloudy weather. The cooling effect at night is of course unfavorable to growth then; but the night is a period of comparative rest, so that the nocturnal cooling off is far more than counterbalanced by the higher temperatures secured during the day.

Windbreaks may appear undesirable for the protection of orchards in blossom or garden crops which are not hardy, because the danger of still frost seems increased by the stagnation of the air on the lee side. The added danger is more apparent than real, however, for still frosts only occur when there is practically no wind, and a windbreak can then have little effect one way or the other. Furthermore, complete stagnation of the air may be helpful rather than harmful if smudging is resorted to.

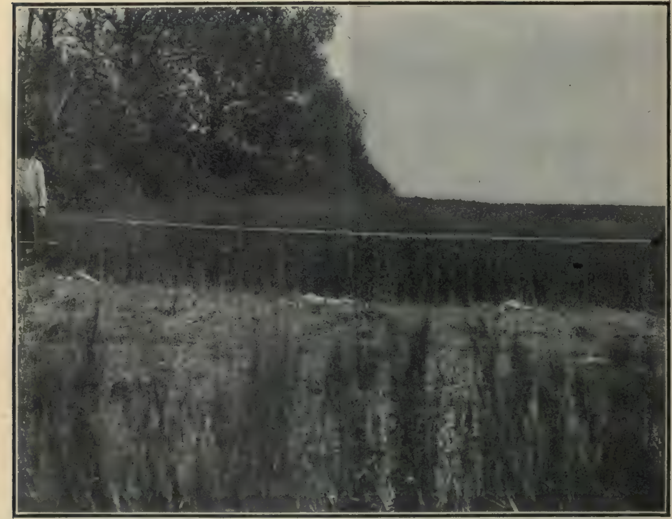

FIG. 5.—Wheat near the trees has been benefited by the covering afforded where snow drifted in the lee of the windbreak.

The freezing which often causes the most severe damage to orchards is that which follows a cold rain or late snow. During such a freeze the damage to blossoms is greatly reduced by protection from wind; for evaporation which produces a rapid cooling increases in proportion to wind velocity. During a freeze of this kind in Nebraska in 1908, fully protected orchards yielded crops many times as heavy as those without exterior protection, and even the leeward side of individual trees exposed to the wind suffered much less damage than the windward side. It is noteworthy also that the one storm of rain and snow, with a temperature of 28 degrees, did all the damage during the season, and that later frosts with lower temperatures did not affect the orchards.

EFFECT OF THE WINDBREAK ON YIELD OF CROPS.

The effect of a windbreak on crops is not beneficial in every respect. There are certain ways in which it is plainly injurious. Trees in a windbreak always spread their roots extensively into the adjoining fields in search of moisture; and they take not only the moisture but some of the nitrogen content of the soil. Furthermore, by shading the ground they may prevent crops from developing properly.[1]

Whether the total effect of a windbreak is good or bad depends upon whether the benefits derived from its influence on wind movement, temperature, and evaporation are greater or less than the injury resulting from the sapping and shading of the ground near by.

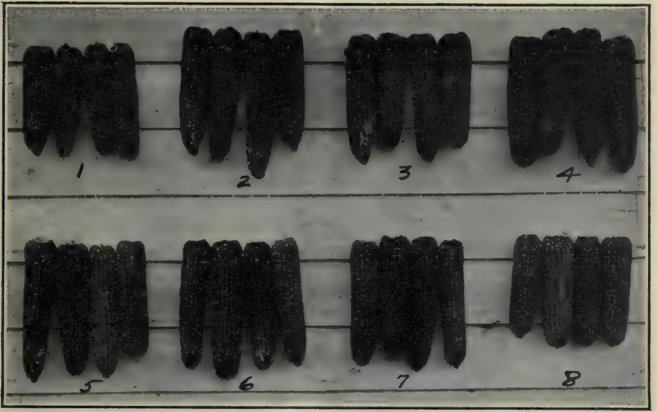

FIG. 6.—Effect of windbreak protection on quality of corn. *1*, In rows shaded by trees; *2–7*, average maximum ears from protected rows; 8, ears from unprotected portion of field.

To determine the total effect, crop measurements have been made in Nebraska, Kansas, Iowa, and Minnesota. Average rather than exceptional conditions were measured, the object being to discover the effect of those influences which are continuous and affect every annual crop grown.

Measurements made in fields of small grain indicate that the crop gain in the protected zone is sufficient to offset fully the effects of shading and sapping. In a wheat field protected by a dense windbreak the gain amounted to about 10 bushels per acre where the protection was most complete, and gradually grew less as the distance from the windbreak increased. The total gain was about equal to the amount of grain which could have been grown on the shaded ground near the trees. The season in which the measurements were taken was not of high winds, nor did it lack moisture. It would appear, therefore, that in a windy year when evaporation was high the total gain for the field would much more than balance the loss. In another case, barley on the south of an ash and honey locust windbreak benefited very materially from the accumulation of snow in the lee, and the conservation of this moisture. Here cultivation was possible within 4 feet of the stems of the trees, so that the increased yield of the field, amounting to about 14 bushels per acre at the highest point, was practically clear gain. The total gain for the whole field amounted to the yield of a strip of ground as long as the windbreak, and three times as wide as its height. In other words, had the windbreak, which was 20 feet high, occupied a strip of ground 60 feet wide, the gain in the field crop would have paid the rental on all of this ground.

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[1] Some crops do better than others when shaded. Seeding crops, such as timothy and alfalfa, are least affected; grains which develop early in the spring, such as oats and wheat, are most affected, and corn occupies an intermediate position.

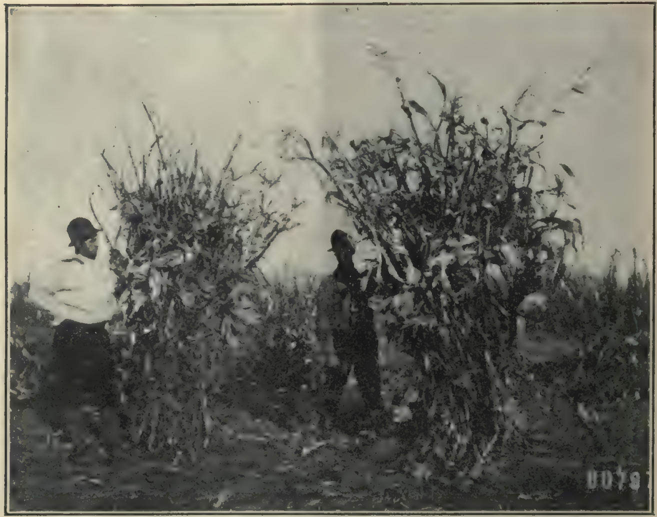

FIG. 7.—Effect of favorable atmospheric conditions on growth of corn plants and yield of fodder. On right, in protected zone (weight, 81 pounds); on left, in unprotected zone (weight, 42 pounds).

The corn crops showed more consistent and marked benefits from protection than any others. In the region concerned the summer winds are almost wholly from the south, so that the only effective rows and belts extended in an east-west direction. The effect on corn was very marked for a short distance on the south side of such windbreaks and for a much greater distance on the north side. Fields of young corn showed much better growth in the area protected and warmed by the windbreak. The effect was visible to the eye early in the season, which was rather cool. Height measurements on one field showed the plants to be 4½ feet high in the first 18 rows next to the windbreak, while beyond this protected zone the height was only 2½ feet. This luxuriant growth was still in evidence at the end of the season, and not only produced more fodder, but bigger and heavier ears. The field showed a production of 59 bushels to the acre in the protected part and only 41 bushels in the exposed part. The net gain, including the area shaded by the grove, was equivalent to the yield of a strip twice as wide as the height of the trees, which were 38 feet high. The increased yield paid, then, for a strip 76 feet wide. The windbreak happened to be wider than this, but need not have been to afford the same amount of protection.

With ordinary field crops the farmer may count on a benefit from windbreak protection which will make the loss of the area occupied by the trees negligible. Under Middle Western conditions a windbreak whose width does not exceed two or three times its height will more than pay for itself, regardless of the timber which it may produce. Farther east the same kind of influence and benefit will exist, though in a less marked degree, and a greater direct return may be expected from growing the timber for its own value, so that the need of even a slight amount of protection should make windbreak planting attractive.

WHERE AND WHAT TO PLANT.

In any region the windbreak should be so laid out as to offer the greatest resistance to damaging winds and to protect the greatest area. This simply means having the belt or row at right angles to the prevailing winds.

In most of the Middle West the principal wind to be feared is the drying south wind of summer. Where the soil is reasonably moist, the cottonwood belt, extending east and west across the southern boundary of the farm, is preeminently the windbreak for this region. It may be supplemented by other east-west windbreaks or hedges, dividing the farm into lots and fields, and made up of mulberry or osage orange, green ash, or locust, depending upon the moisture of the soil. The cottonwood windbreak is recommended because it so quickly attains great height and produces so much wood for fuel. After it has grown, however, it may need underplanting or side planting to fill the gaps in the lower story. The underplanting, if any, must be done within a few years after the planting of the cottonwood. For this purpose green ash or red oak is recommended. On the drier situations the main planting must be done with some of the more drought-resistant species which do not attain such great height. Green ash or locust for the main belt and osage orange for the hedge can not be excelled.

In the western part of this region more attention may have to be given to westerly winds, and the direction of the rows changed. In eastern Colorado, for instance, the windbreak must be planted so as to afford protection from the spring winds from the west, which are often very damaging.

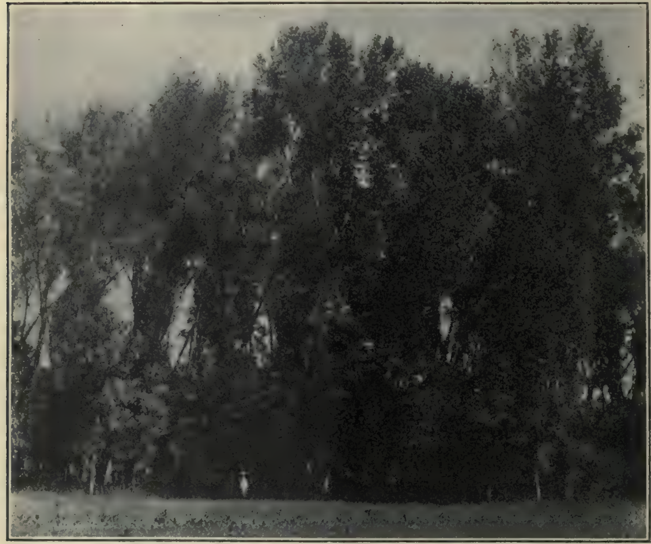

FIG. 8.—When mature, cottonwood must be underplanted if the belt is to retain its efficiency.

On the northern prairies (western Minnesota and the Dakotas) southerly summer winds are not so much felt as the westerlies. Here windbreaks should be mainly north-south ones, although some protection on both the north and the south sides of the farm may be needed. Scotch and Norway pines, Colorado blue spruce, and Black Hills spruce are recommended where moisture is sufficient for them, because they give so much better winter protection than the hardwoods. On drier situations western yellow pine may be substituted for the Norway.

In the Lake States practically all damaging winds are from the west, although the orchard may need just as much protection from the easterly winds which usually precede and accompany a storm. White pine is recommended above all other species, because of its rapid growth and high timber value, which justify its planting in wide belts or groves. The planting of white cedar along the edges of older white-pine belts will greatly increase the efficiency of the existing windbreak. On the poorer soils Norway or Scotch pines may be used instead of white pine.

In the Eastern States the situation is essentially the same as in the Lake States. White pine may be generally used, and white and Norway spruces and white cedar may be used in mixture or to strengthen the older windbreak on the sides.

In the Southwest the choice of species is very limited, and in typically dry situations possibly nothing can be made to succeed which has greater value than sagebrush in the form of hedges placed at frequent intervals. With a little more moisture the native evergreens, piñon, alligator juniper, and cedars may be made to grow. With irrigation the species used in the Middle West can undoubtedly be utilized to good advantage. If possible, the windbreaks should extend northwest-southeast.

In California citrus orchards and other valuable crops need protection on all sides. Protection from the northerly "Santa Ana" is probably most essential to grains and other field crops. For all of these purposes Monterey cypress, Monterey pine, and eucalypts have proved very valuable.

In the Columbia River region of the Northwest, Carolina and Lombardy poplars and cottonwood are very efficient for the protection of orchards and crops against the mountain winds, usually of easterly origin. Even small willows have been used to good advantage in checking the drifting of sand.

GROUND SPACE NECESSARY.

The belt of trees forming a windbreak needs the use of a certain amount of ground beyond that on which it actually stands. There must be space for the roots to spread out in search of soil nourishment and moisture. It should be remembered that the row of trees is a productive agent quite as much as a row of corn and may need just as much growing space in proportion to its height. Some species of trees, of course, spread their roots wider than others and need more space. Of those commonly planted, mulberry, honey locust, and osage orange spread the farthest in proportion to their height, and green ash spreads the least. Cottonwood does not spread its roots so far as is generally supposed.

Cultivation tends to limit the spread of the roots by making more moisture available near the trees, though deep plowing or cutting the roots restricts the root extension at the expense of the growth of the trees themselves. On the other hand, competition between trees, where several rows are planted together, tends to make those on the outside of the belt push their roots farther out into the open ground.

The width of the strip of ground to be allowed the windbreak may be figured at from one and one-fourth to twice the height of the trees; for instance, a single row of trees 50 feet high should be allowed a strip of ground from 62 to 100 feet wide.

DIRECT RETURNS FROM PLANTING.

In addition to affording protection to crops and buildings, the windbreak usually has considerable value as a source of wood supply for use on the farm or for sale. In the following estimates of the timber value of various kinds of windbreaks the acreage on which the figures are based includes not only the ground actually occupied by the trees but also that which is shaded and sapped. The estimates are for annual income per acre, discounted at the rate of 4 per cent from the final value of the timber when cut. No allowance is made for the cost of planting.

Cottonwood rows and narrow belts planted on fairly moist bottom lands yield an income of from $2.64 to $8.01 per acre, the greatest values being obtained by cutting after the age of 40 years. Good returns can not be expected from any but moist situations.

Willow planted on thoroughly moist soil yields from $4.17 to $15.81 worth of posts per acre, the highest values being realized when cutting is done between the ages of 14 and 20 years. When utilized for fuel, willow yields an income of from 72 cents to $2.78.

Green ash yields from $2.53 to $6.51 in posts on the best class of soils, and from $1.84 upward on poorer soils. It is an excellent auxiliary to cottonwood, but will make good growth on much more unfavorable situations.

Honey locust is capable of growing on dry ground but grows very rapidly where there is more moisture. On dry ground it produces from $1 to $4.10 worth of posts per acre; on moist soil from $1.84 to $5.42 per acre. When cut and allowed to make sprout growth it may produce even larger yields.

Osage orange may return as high as $12.51 per acre on the best soils. Its value on second-class soils is from $3.94 to $11.85. Even on third and fourth class soils it may return as much as $6 per acre. Osage orange not only produces posts that are hardly exceeded in lasting qualities by those obtained from any other species but is capable of growing on very dry situations.

Russian mulberry planted in favorable situations usually produces a number of rapid-growing shoots from each root, which makes it a highly valuable post producer as well as an almost impenetrable windbreak. This species yields a return of from $8 to $30 per acre, the largest returns being secured by cutting at about 10 years of age. It requires good moisture conditions and is unable to withstand severe winter temperatures.

Silver maple returns from 72 cents to $1.54 per acre, the largest amounts being obtained from windbreaks about 25 years old. The species is used chiefly for fuel.

White pine attains its best value only when grown to log size. This may be reached in windbreaks in 30 years or a little longer. The annual value of the growth is about $4 or $5 per acre, according to the market for the timber.

Scotch pine has not as high a value for lumber as white pine; on most farms the fuel value is greater than the lumber value. This tree is capable of producing returns of from $2 to $4 worth of fuel per acre on moist soils. A very sandy soil will not hinder its growth.

These estimates indicate that it is advisable to treat the windbreak as an asset and to give it the same care as the other productive agents on the farm, so that it may become a source of revenue as well as a comfort and a protection.

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MUSHROOM PESTS AND HOW TO CONTROL THEM

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Entomological Assistant, Truck Crop and Stored
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FARMERS' BULLETIN 789

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. February, 1917

IN THE construction of a mushroom house, care should be taken to make the building as tight as possible, with outlets capable of being tightly closed. All windows and ventilators should be screened with fine wire gauze; this forms an excellent prevention against the entrance of both fungus gnats and the mites which they carry.

Mushroom spawn should be purchased only from reliable dealers.

The preparation of the compost should be careful and thorough, and the temperature of the house should be kept as low as possible, preferably below 55° F., thus reducing to a minimum the multiplication of any insects which may be present.

If the manure is carefully selected and properly composted and the temperature and moisture conditions are right, it should seldom be necessary to resort to such radical measures as fumigation, sterilization, or the destruction of the beds.

MUSHROOM PESTS AND HOW TO CONTROL THEM.

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INTRODUCTION.

CULTIVATED mushrooms are subject to attack by a variety of pests, especially during warm weather. Some of these may be brought into the house in the compost of which the beds are composed, attacking the mushrooms through preference, while others feed normally upon mushrooms, and are attracted from the wild forms outside through the greater abundance of their natural food plant in the cultivated beds. Injury by these pests frequently becomes serious. This bulletin treats of the measures for the protection of the crop from such injury.

The insect and other pests which usually attack cultivated mushrooms, and those of which complaints are most frequently made, may be divided roughly into four classes, namely, mushroom maggots, mites, springtails, and sowbugs. Of these the maggots are the most generally injurious, the mites following in order of importance, owing to the difficulty with which their eradication is accomplished, and then come springtails and sowbugs in the order named.

MUSHROOM MAGGOTS.

The injurious forms commonly known as "mushroom maggots" are small, whitish or yellowish-white maggots, usually having black heads. They are the larvæ, or young, of certain small, two-winged fungus gnats or flies, usually black or blackish in color, and belonging to several species.[1] They are minute, measuring only about one-tenth inch in length and about one-eighth inch in spread of wings. They are rapid and prolific breeders, especially during warm weather, frequently occurring in mushroom houses so abundantly as to darken the windows. They may be readily confused, however, with gnats of the same genus which breed in manure or in greenhouse soil, and determinations of the species should always be made by a specialist.

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[1] The species attracting the most attention as pests are *Sciara multiseta* Felt, *Sciara agraria* Felt, and *Aphiochaeta albidihalteris* Felt (see fig. 1). They belong to the two families of flies known as Mycetophilidae and Phoridae.

The life history of a mushroom maggot is about as follows:

The eggs, of which each female is capable of laying nearly 1,000, generally are deposited at the juncture of the stem and cap of the mushroom or in the manure or soil at its base. In a warm temperature they may hatch within 3 days, but in colder weather this time is considerably extended. Upon hatching, the larvæ bore at once into the stem or cap of the mushroom, soon riddling the cap and causing the "breaking down" of the mushroom. On account of the perishable nature of their host they must necessarily pass through their transformations quickly. The larvæ feed from 7 to 10 days, by which time the entire cap is destroyed; they then enter the ground, each spinning a slight silken cocoon just beneath the surface, and pupate. The pupa stage lasts from 4 to 7 days, after which the insects emerge as adults and soon pair and lay eggs for the next generation. Owing to the immense number of eggs deposited and to the short life cycle, the rapidity of their increase is remarkable, so that the presence of only a few insects in the mushroom house at the beginning of the season may result in millions after the beginning of warm weather, thus effectually preventing the cultivation of mushrooms.

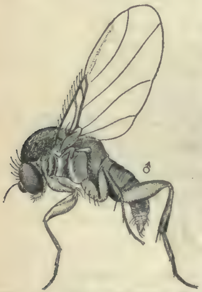

FIG. 1.—A mushroom fly, *Aphiochaeta albidihalteris:* Male. Much enlarged. (Author's illustration.)

CONTROL.

Where it is possible to keep the temperature of the mushroom house at 55° F. or to reduce it to that temperature upon indications of attack by maggots, damage by these pests is easily controlled. Otherwise it is evident that, in the control of the mushroom maggots, measures should be undertaken early in the season for their elimination from the mushroom house and precautions observed against their subsequent entrance. These precautions should begin with the construction of the house or cellar. The building should be so constructed as to permit of effective fumigation and should be fitted with tight screens of fine wire gauze, suitable to prevent the ingress of the fungus gnats. The gnats may also be brought into the house through the agency of the manure used in the beds, especially if the compost is carelessly prepared. In large commercial houses the care taken to secure uniformity in the fermentation of the compost renders improbable any danger from this source, since a uniform heat of 150° F. or more is frequently attained in the process, this being sufficient to destroy maggots and other pests which may be present. In case of serious infestation of the compost before planting, however, it may be well to disinfect or sterilize this substance by means of steam heat. This may be accomplished for small houses by placing the manure or soil in vats or boxes through which steam pipes are conducted. (See fig. 2.) In large mushroom houses, which are heated by steam, a number of pipes may be laid beneath the surface of the beds, in a manner similar to that used in greenhouses for sterilizing the soil of the benches. The manure should be heated to a temperature of 150° F., which will destroy all animal life occurring therein without injury to its capacity for producing mushrooms. Fumigation with carbon disulphid just previous to spawning is also productive of good results in destroying maggots in the compost. The disulphid should be used at a strength of 2 to 4 pounds to 1,000 cubic feet of space and should be evaporated in shallow pans placed in the highest part of the house. *Carbon disulphid is very inflammable and the liberated gas is explosive when brought into contact with fire or sparks, so that care should be used to avoid bringing any fire into the building during the process of fumigation.*

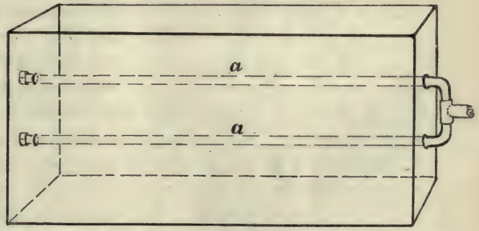

FIG. 2.—Steaming box, or sterilizer, for the treatment of compost. (Author's illustration.)

One of the best methods for the destruction of the adults or flies in their occurrence in mushroom houses is fumigation with tobacco or nicotine preparations, such as are used in greenhouses. These should be used in accordance with the directions indicated on the package for a medium or heavy fumigation.[1] Used in this manner and applied once a week during the bearing season of the mushroom bed, this method has been so successful in reducing the number of flies that very little damage, if any, resulted from the larvæ.

Fumigation with best quality fresh pyrethrum insect powder or dusting the powder over the beds is also effective against the mushroom maggots if taken in time, but tobacco fumigation may be considered standard for this use.

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[1] The proportion of nicotine in the several preparations varies to such an extent that no standard dose has as yet been formulated.

THE MUSHROOM MITE.

The mushroom mite[1] (fig. 3) is a minute, soft-bodied mite, smooth skinned, and white or whitish in color. It is closely allied to the common cheese mite[2] and resembles that species in appearance. It is, if anything, more prolific, becoming at times so abundant in mushroom beds as to cover the surface of the compost; when present in such numbers it is extremely destructive, feeding upon the mushrooms in all stages and penetrating the beds and destroying the mycelium.[3] Indeed, in one case observed, the mycelium was destroyed as fast as it was produced.

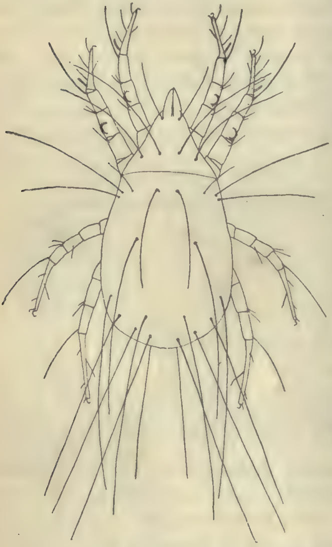

FIG. 3.—The mushroom mite (*Tyroglyphus lintneri*). Highly magnified. (Banks.)

This species is undoubtedly the cause in many cases of the failure of the spawn to propagate, which is likely to be attributed to poor or weak spawn or to defective cultural conditions. The minute size of the mites causes their presence to be overlooked and the failure of the spawn to produce mycelium is not understood. Even under conditions favorable to the growth of the mycelium it is possible for the mites to increase to such an extent that the entire bed may be killed out.

Besides the injury to the mycelium, mushroom mites cause damage to the fruiting bodies by eating into them, distorting or destroying the young growth. In the more mature mushrooms the mites may be found clustered in groups consisting of individuals of many sizes, usually hidden in the folds between the gills, where they burrow into the tissue, causing the caps to break down.

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[1] *Tyroglyphus lintneri* Osb.

[2] *Tyroglyphus siro* L.

[3] The term mycelium, as used herein, is applied to the new growth of spawn through the compost, as differentiated from the original insertions of spawn.

No direct observations on the life history of this species have been made, but judging from that of related species it is about as follows: The eggs, which are large in proportion to the size of the mites, are laid in or about the mycelium or on the young developing caps. They hatch in a short time into the characteristic 6-legged young, which soon become mature. The time from the deposition of the egg to the maturity of the mite has not, so far as the writer knows, been worked out accurately, but it undoubtedly occupies only a few days. It is on this account that the mite is able to increase so rapidly, apparently as if by magic, and thus give rise to the theory of spontaneous generation sometimes advanced to explain this condition.

Under certain conditions the hypopus or migratory stage is produced. This stage, so far as known, is peculiar to the family Tyroglyphidae, to which this mite belongs, and is very remarkable. The mite develops a hard, chitinous covering, has no mouth parts, and is provided with short legs insufficient for walking. On the ventral surface of the body is an area provided with sucking disks, by means of which the hypopus attaches itself to an insect and is so transported to suitable breeding grounds in other localities. On arrival at a suitable breeding place the mite detaches itself from its insect host, molts, and soon becomes adult. During the hypopus stage the mite takes no food and causes no injury to the insect which carries it. This peculiar stage is the natural means for the distribution of the mite to new localities, and is in many cases responsible for its appearance in localities far from previously infested beds.

In addition to the means mentioned above, the mite may obtain access to mushroom houses in infested compost or in spawn from infested houses. The greater part of the infestation, however, probably takes place through the agency of the small flies which frequent mushroom houses and which carry the hypopus stage of the mite from one house to another.

REMEDIES.

Little can be recommended for the control of the mushroom mite after it has once become established in a house. Owing to the absence of breathing pores it is practically unaffected by fumigants suitable for the control of other mushroom pests, while applications of sulphur, tobacco dust, and other insecticides to the beds seem only to prove slightly inconvenient to the mite. It is one of the most stubborn pests encountered in mushroom culture, and may be brought into the house in almost any manure that is used for the bed. When in the hypopus stage it is capable of prolonged suspension of vitality and is likely to remain in the house for an almost unlimited time without death. The only measures, therefore, that may be considered are those of prevention.

When a house becomes infested all compost should be gathered with the utmost care, removed to the outside, and thoroughly disinfected by drenching with boiling water, or it may be hauled to a distance and spread upon the ground as fertilizer or destroyed by burning. The ground occupied by the mushroom beds should be thoroughly scalded, and the woodwork of the mushroom house treated to a wash of creosote or crude carbolic acid, either of which is repellent to the mites. After complete disinfection has been accomplished the house should be screened, to guard against subsequent introduction of the pest by means of flies. All manure forming the beds should be steamed, according to the directions under the head of "Mushroom maggots." Care should be used to purchase spawn coming from reliable sources. With these precautions it is unlikely that trouble will be experienced from the attacks of mushroom mites. Close watch should be kept, however, for any signs of their presence in the beds, and the compost destroyed upon their first abundant appearance, as it is impossible to secure good results with mushrooms when they are once thoroughly infested by these mites. All applications of sufficient strength to destroy the mites are likewise injurious to the mushrooms, and it is futile to attempt to control them by any artificial means once the mushroom bed has become infested, as the mites are buried so deeply in the compost that no insecticide will reach them.

A predacious mite, which belongs to another family,[1] frequently occurs in beds infested by the mushroom mite, feeding upon the latter, and at times becoming so numerous as entirely to wipe out the pest. This predacious mite may be known by its longer legs and its manner of running swiftly over the compost or the mushrooms. Cases have been observed where it has occurred in such abundance as greatly to outnumber its host. It does not attack the mushrooms after the destruction of the mushroom mite, but seeks other feeding grounds or dies of starvation.

SPRINGTAILS.

At times the surface of a mushroom bed becomes alive with minute brown or black insects which, when disturbed, leap about like fleas in an extremely erratic manner. These are known as springtails,[2] since the springing is performed by the aid of two short bristles situated on the end segment of the abdomen. These insects (see fig. 4) are often attracted to the manure used as compost, where they feed on the decaying vegetable matter present, but on occasion they may become very injurious in mushroom houses. A correspondent in St. Louis, Mo., reported that in one of his mushroom houses a bed 150 feet in length had been completely destroyed by these pests, which attacked the mushrooms as fast as they appeared, honeycombing them and rendering them unfit for use. The method of attack of this insect is to feed upon the fruiting bodies of the mushrooms, destroying both the gills and the cap. Hundreds may be found clustered upon a single mushroom and eating large cavities in the gills. It appears to be a habit of these insects to congregate in large numbers on caps which have been slightly injured, in which case they rapidly destroy mushrooms which would be readily salable if the injury were not continued. When they occur in large numbers they are likely to attack even the perfect mushrooms, in aggravated cases destroying whole beds.

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[1] Gamasidae.

[2] *Achoreutes armatum* Nicolet et al.

Insects of this group pass through no larval transformation, the form of the newly hatched young being similar to that of the adult. They are thus likely to be injurious in the same manner throughout their life history.

REMEDIES.

The remedial measures applicable to the control of springtails are to a large extent preventive, as these insects are somewhat difficult to destroy when once established in a mushroom bed. Springtails are quite resistant to tobacco powders, but applications of "buhach" or pyrethrum insect powder to the beds are productive of some good. As they usually congregate near the surface of the beds, fumigation with hydrocyanic-acid gas according to the directions given in Farmers' Bulletin 699 will prove effective in reducing their numbers. The cyanid should be used at a strength of from 3 to 6 ounces to each 1,000 cubic feet of air space, which will not prove injurious to the mycelium. The fumigation should be applied after picking, as the gas "burns" the caps severely, causing them to turn brown.

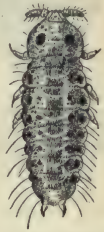

FIG. 4.—A common injurious springtail, *Achoreutes armatum*. Much enlarged (Author's illustration.)

By way of prevention, steaming all manure, as previously suggested for other species, will destroy springtails. Where possible it is better to grow the mushrooms at a temperature of about 55° F. than higher, since at low temperatures the springtails breed more slowly. Dusting the tops of the beds with powdered lime is also said to discourage attack by springtails.

SOWBUGS.

Considerable injury is often accomplished to mushroom beds through the attacks of oval, grayish or slate-colored creatures bearing seven pairs of legs. These creatures are not true insects, although known variously by the terms "woodlice," sowbugs, and "pillbugs." Two species, the greenhouse pillbug[1] and the dooryard sowbug,[2] are illustrated in figures 5, 6, and 7.

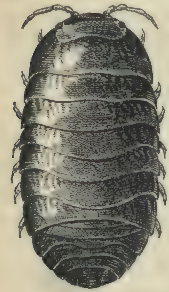

FIG. 5.—The greenhouse pillbug (*Armadillidium vulgare*) extended. Much enlarged. (Author's illustration.)

Sowbugs frequent damp, dark places, such as those beneath boards, in cellars, and in the cracks of sidewalks. When disturbed, many species roll up to form a ball, lying quite still until the danger is past. (See fig. 6.) During the night they issue from their hiding places to feed upon decaying vegetable matter, molds, and other material present in damp soils, although at times the roots of plants and even the green leaves are not eschewed.

The young are carried about in a pouch, formed by several modified anal plates on the abdomen of the female, until able to shift for themselves. When released by the female the young are similar in appearance to the adults, although much smaller, and are likewise capable of damage. There is probably only one generation annually, the young making their appearance in the spring and requiring one summer to reach maturity.

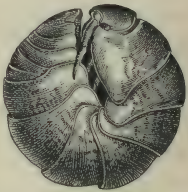

FIG. 6.—The greenhouse pillbug (*Armadillidium vulgare*) contracted. Much enlarged. (Author's illustration.)

The destruction occasioned by sowbugs is due to their attacks on the caps or fruiting bodies of mushrooms. These they attack while quite small, destroying them or injuring their appearance. They do not, as a rule, attack the mycelium, but eat holes in the young "buttons," which, on the completion of the growth, become much larger and disfigure the product.

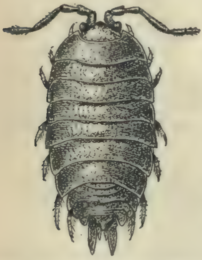

FIG. 7.—Dooryard sowbug (*Porcellio laevis*). Much enlarged. (Author's illustration.)

Sowbugs are frequently carried into the mushroom house in compost which has been allowed to stand outside. The heat of the manure is relished by them, and they collect in numbers, remaining throughout the growth of the spawn and becoming injurious with the first growth of the mushrooms. The writer has seen sowbugs collected in manure piles to such an extent that numbers aggregating a pint or more in quantity might have been collected from a shovelful of material.

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[1] *Armadillidium vulgare* Latreille.
[2] *Porcellio laevis* Koch.

REMEDIES.

Where the mushroom house is small in extent it is possible materially to reduce the numbers of sowbugs by means of hand picking. The house may be visited at night, when by the aid of a lantern numbers of sowbugs may be seen crawling about on the earthen casing of the beds and upon the boards and supports of the benches. These may be destroyed with a small wooden paddle.

It is also possible to secure good results by pouring hot water along the cracks in the boards and in other places where the "bugs" may be concealed by day. This is effective in small establishments, but is somewhat difficult of application in large houses. In such a case fumigation with hydrocyanic-acid gas is an effective remedy.

Another method is to cut small pieces of raw potato, plastering the wet surface with Paris green, and laying them about on the beds in the localities affected by the sowbugs. This method is frequently successful in entirely ridding houses of this pest.

A modification of this treatment successfully used by the writer in the destruction of sowbugs in greenhouse benches is the application of the ordinary poisoned-bran mash commonly recommended for the destruction of cutworms and grasshoppers. This bait is prepared as follows:

Bran	pounds	25
Paris green or white arsenic	do	1
Oranges or lemons	do	6
Cheap sirup or molasses	quarts	2
Water	gallons	4

The bran should be placed in a washtub or similar container and the poison added while dry. These should be thoroughly mixed and then the water, to which has been added the sirup and the finely chopped fruit, should be stirred into the mixture until a wet mash is formed. After the mash is allowed to stand an hour or two, it may be scattered thinly on the infested beds.

SLUGS.

The appearance of conspicuous, ragged holes eaten into the caps of mushrooms (see illustration on title page) during the night may often be traced to the presence of the large imported garden slug.[1] These unpleasant creatures are extremly fond of mushrooms, issuing from their hiding places toward evening, and, leaving a trail of slime behind them, proceeding in search of their favorite food.

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[1] *Limax maximus* L.

The damage to mushrooms is not confined to the cultivated species, but may frequently be observed to those growing in woods and fields. It is characterized by the rough, gouged-out appearance of the holes, which seem as though excavated by a mouse or rat. The creature itself resembles a shell-less snail from 2 to 7 inches in length and is grayish brown to pitchy black in color, usually with numerous elongate black spots. The eyes are borne on two pedicels or stalks which are retracted within the body when the mollusk is disturbed.

The imported garden slug deposits its large, round, transparent, yellowish eggs in gelatinous clusters beneath boards or refuse over moist earth. There is one brood each year, the young hatching in the spring and becoming half grown by fall. As with other mollusks, life extends over a period of several years. The individuals usually frequent moist spots in gardens or lawns and feed on the herbage, but frequently they invade mushroom houses, where their injury becomes almost immediately noticeable.

REMEDIES.

The usual remedies for slugs, trapping by means of poisoned or other baits, are inapplicable when these creatures occur in mushroom houses, since they prefer fresh mushrooms to any other food which might be used. It is therefore necessary to use hand methods of collection, such as are mentioned under the head of "Sowbugs." Such measures should be undertaken as soon as the injury is noticed, for if individuals are allowed to breed in the house their elimination will be much more difficult. Advantage may be taken of the habit of these slugs of returning to the same place of concealment each day, and they may be sought out with a lantern and destroyed or captured during the night while engaged in feeding. They are repelled by dust, powdered lime, or ashes and will not cross a line composed of one of these substances. Small beds may thus be protected from their ravages—for a time at least. Pulverized salt is another valuable deterrent.

CRICKETS.

Among other injurious forms which at times attack mushroom beds, certain crickets are reported as eating into the caps of the mushrooms.[1]

The remedies for crickets in their injurious occurrence are the same as those recommended for sowbugs. Potatoes and carrots may be minced before the Paris green is applied, in order that a somewhat thicker coat may be secured.

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[1] On the Pacific coast a species known scientifically as *Ceuthophilus pacificus* Thom. has been reported as causing extensive injury to cultivated mushroom beds.

GENERAL SUMMARY.

In the construction of a mushroom house, care should be taken to make the building as tight as possible, with outlets capable of being tightly closed. All windows and ventilators should be screened with fine wire gauze; this forms an excellent prevention against the entrance of both fungus gnats and the mites which they carry, as previously mentioned. The importance of purchasing spawn from reliable dealers may be emphasized here. The preparation of the compost should be careful and thorough, and the temperature of the house should be kept as low as possible, preferably below 55° F., as at a low temperature all insects are more or less dormant, and their otherwise rapid multiplication is thereby reduced to a minimum, with corresponding reduction in infestation. Using carefully selected manure, properly composted, and with proper temperature and moisture conditions, there should be little necessity for the radical measures of fumigation, sterilization, or destruction of the beds.

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CONTAGIOUS ABORTION OF CATTLE

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FARMERS' BULLETIN 790

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
A. D. MELVIN, Chief

Washington, D. C. January, 1917

CONTAGIOUS abortion in cattle is a germ disease which causes the death of unborn calves and occasions annual losses of millions of dollars. If it continues to increase it will soon surpass tuberculosis, which is now thought to stand first among animal diseases in point of economic loss.

A bull may spread the germ from a diseased cow to healthy animals. One aborting cow in a herd may infect the whole herd.

Every cow that shows the disease should be isolated. The fetus and all discharges should be burned or buried and the stall disinfected thoroughly. The cow should be treated systematically with mild antiseptic douches, and she should not be bred again within two months and not then if the discharge has not ceased.

The premises should be cleaned, disinfected thoroughly, and thereafter maintained in a sanitary condition.

A cow that has aborted is likely to become immune to the disease, therefore if she is a profitable animal it is best to keep her.

Details of the disease and its treatment are given in the following pages.

CONTAGIOUS ABORTION OF CATTLE.

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EXTENT OF CONTAGIOUS ABORTION.

Contagious abortion of cows, it was estimated a few years ago, caused an annual loss of $20,000,000, but since that time it has continued to spread rapidly and widely throughout the country. In economic importance the disease is second only to tuberculosis, and is fast approaching first place. Formerly confined almost entirely to dairy cows, it has now spread to the beef herds upon the range, where the losses are proving especially severe. It is imperative that the stockmen, as well as the dairymen, awake to the seriousness of the situation, and combine for a systematic campaign against the disease.

NATURE OF ABORTION DISEASE.

Abortion disease is a specific, infectious disease, which is caused by a small germ known as the *Bacillus abortus* of Bang. The chief and best known symptom of the disease is the death and expulsion of the undeveloped fetus. This is brought about by the entrance of the germ into the pregnant uterus, where, growing and multiplying, it causes a separation between the maternal and fetal membranes. The attachment between the fetus and the mother being thus broken, the fetus is not supplied with nourishment and oxygen, and of course dies. It then acts as a foreign body and is expelled, and this is called "abortion." Thus it can readily be understood that abortion is but one of the symptoms and not the disease itself.

Other manifestations are recognized by those familiar with the disease. The infection does not always result in the death of the fetus. It frequently happens that the resisting power of the mother prevents abortion, or that the disease-producing power of the germ is not great enough to kill the fetus, and the calf is born alive and at full term. Under these conditions an inflammation is frequently produced which causes adhesions of the membranes, and there occurs what is known as retained afterbirth. Unless these membranes are removed in a proper manner their subsequent decomposition will produce inflammation of the uterus, or even blood poisoning, which may cause the death of the cow.

Sterility is another sequel of abortion. Frequently it is a result of neglect following an abortion or retained afterbirth, where infection with pus-producing germs causes permanent changes in the genital organs. Again, sterility may be but temporary, from the persistence of the infective agent in the uterine cavity. But whatever the cause, sterility can, to a considerable degree, be prevented by prompt treatment following abortion and retained afterbirth.

White scours and calf pneumonia are common accompaniments of abortion, and exact a heavy toll.

An animal may have acquired infection and not abort, or the calf may be born alive at full term but be so weak that it soon succumbs to one of the calf ailments; yet that cow is just as truly affected with abortion disease as though she had dropped an undeveloped fetus at seven months. The foregoing facts add to the complexity of the problem and the difficulty of overcoming the disease.

Many persons have thought that abortion was due to various other causes, such as injury, spoiled feed, or certain herbs; but by far the largest percentage is of the infectious type. Abortions do occur, however, in the course of other diseases, where as a result of the disturbed condition of the maternal circulation the fetus is not properly nourished and dies. It is likewise possible for injury to cause the death of the undeveloped animal, but the fetus is so well protected within the body of the mother that more than the ordinary injury is required to cause its death.

SYMPTOMS.

The signs of approaching abortion are usually those which precede normal calving, with the exception that they are premature. Two or three days before abortion there will be swelling of the udder ("making bag"), swelling of the external genitals, and the appearance of a mucoid or mucopurulent, odorless discharge from the vagina. These symptoms may not, however, always appear, and abortion may occur without warning. In young animals and in those aborting for the first time the abortion usually occurs at an early period, and the fetus, surrounded by the intact membranes, is expelled. This may occur in the third or fourth month of pregnancy and may pass unnoticed because of the smallness of the fetus and the absence of any disturbance in the health of the cow. It may then be thought that the cow had failed to conceive. On the other hand, where abortion takes place in the seventh or eighth month of pregnancy, retained afterbirth is a common occurrence, and the act is accompanied by restlessness and pain. In some cases pregnancy may continue almost to full term and the calf may be born alive but weak and may soon die. In herds where the disease is known to be present these cases too should be considered as abortions.

Following abortion there is a characteristic dirty, yellowish-gray, flaky, and at times bloody discharge, which may persist for two weeks or more. If the membranes are retained their decomposition may cause blood poisoning and death, or if the cow is able to survive, permanent changes may result which render her permanently sterile. If proper treatment is given promptly, these changes frequently may be prevented and the breeding function preserved to the animal.

In practically all cases of abortion disease, if the affected animals were killed, a variable quantity of a yellowish to dark brown fluid, characteristic of this disease, would be found separating the fetal and maternal membranes. The lining membrane of the uterus is usually swollen, hemorrhagic, and roughened, and in some cases may show areas of decomposition. The cotyledons or so-called "buttons" are most severely affected, frequently being pale, soft, decomposed, and surrounded by exudate. The membranes may be thickened and leathery in appearance. Somewhat rarely the fetus may be retained and dries up to form a mummy. If infection with pus-producing germs follows abortion and persists for a considerable time, the walls of the uterus may become thickened, and the ovaries diseased, and permanent sterility results.

If abortion is not complicated by retained afterbirth or sterility, it does not markedly affect the health of the individual animal. The act of abortion is not accompanied by any disturbance in condition other than is seen in normal calving. The cow continues to eat and act normally, the discharge soon ceases, and she may soon breed again and afterward produce a living calf. Consequently, the tendency among owners has been to assign other reason than infection for the first few abortions, either because of lack of knowledge of the disease or because they were loath to believe that it had gained entrance to the herd. As the disease develops slowly, not much attention usually is given to the first cases; the cows are neglected, the proper sanitary measures are not employed, and the infection is disseminated throughout the herd. This may continue until a perfect storm of abortion, with all of its attendant conditions of retained afterbirth, sterility, and weakling calves, compels attention. If the owner, knowing the danger, had taken proper precautions with the first cases, an outbreak might have been avoided. In view of the insidious nature of the disease and the difficulty of tracing its path of introduction, it is always advisable to regard an abortion as of the contagious variety and to take ample precautions.

HOW ABORTION IS SPREAD.

It is necessary before attempting to control a disease to determine how it is spread. All investigators do not agree as to the avenues of infection, but practically all will admit that the disease is spread either by the bull at time of service or through the digestive tract by means of contaminated feed and water. The germs are contained in the discharge from the genital organs of affected cows and in the aborted fetus and its membranes. Consequently the disease is disseminated throughout the herd by this material coming in contact with the feed, because of insanitary methods about the stable, or by allowing a discharging cow to contaminate the pastures. Moreover, when the bull serves such a cow his genitals become contaminated, and the infection is transmitted mechanically to the next cow he serves. Abortion is usually conveyed from herd to herd by the introduction of a diseased cow, which then infects the bull; or a bull from a diseased herd is purchased, and he in turn infects the cows. Among small herds, where bulls are kept for public service, the disease may be disseminated throughout the community unless suitable precautions are taken. It is evident from the foregoing that by proper disposal of infective material great progress can be made toward the control of the disease, and this fact is the basis of recommendations for a system of treatment which will be given under the proper heading.

IMMUNITY.

Affected cows do not continue to abort indefinitely. Much more than 50 per cent abort but once, relatively few abort twice, and a very small percentage lose their calves the third time, and thereafter they produce living calves. It is evident, therefore, that an immunity is produced. It is the hope of scientists to develop an effective immunizing agent which will induce this immunity without causing the loss of the fetus, but this hope has not yet been realized fully.

This immunity, while highly desirable in the individual animal, is sometimes a source of danger to the herd, in that the immune cow may continue to harbor the infection. These so-called infection "carriers," themselves apparently normal in every respect, may yet contaminate the bulls and in various ways the feed and water. Such cows have been known to excrete the germs in their milk for many years. These facts add to the difficulty of controlling the disease and make necessary the precautions recommended.

Recently biological products such as vaccines, bacterins, and serums have come into use for immunizing cows against abortion, but they have not passed the experimental stage and have not proved entirely satisfactory. Many of the claims made for them by the manufacturers are extravagant and not justified by the facts. It is not the intention to discourage their use, for the theory on which their preparation is based has been found correct in relation to other diseases; but it is desirable that conclusive evidence of their effectiveness be obtained before their general use can be recommended. The partial success of these products induces the hope that an effective immunizing agent may yet be developed. Recent investigations seem to indicate that they are most effective when used several weeks before breeding. The chronic and insidious nature of abortion, however, makes prolonged observation necessary, and several years of experimentation may be required before the true value of these products can be determined.

DIAGNOSIS.

How may the owner know when abortion has gained a foothold in his herd? It has been shown that abortion is nearly always of the specific, contagious type, therefore an abortion, or especially several abortions, occurring under such conditions that other causes can be eliminated, should cause suspicion. The fact that there have been numerous abortions accompanied by the characteristic discharge is sufficient evidence of the presence of the disease.

Investigators, in addition to establishing these facts, employ the blood tests, in which the serum of the blood is tested by special laboratory methods. These are practicable only where the blood samples can be drawn by a veterinarian or other qualified person and suitably prepared and forwarded to the laboratory.

PREVENTION AND TREATMENT.

The owner whose herd has escaped this disease is fortunate. If he is wise he will want to know how to prevent its introduction and will take all necessary precautions. On the other hand, the man into whose herd abortion has already come because he was not aware of the danger will ask for a cure and a means to prevent its dissemination throughout the herd. In the past drugs have been resorted to, and at various times carbolic acid, methylene blue, and other substances have been hailed as specifics, but all have been discarded as ineffective. It may be said with safety that at present *no reliable cure for abortion is known.* The standard antiseptics are more reliable and cheaper than proprietary remedies.

Abortion can to a large degree be prevented and controlled by intelligent and thorough treatment, but a study of the following recommendations will show that it is not a lazy man's job, and that one's best efforts will be required. Moreover eternal vigilance is the price of success.

In combating abortion, where such thoroughgoing methods are required, material, time, and energy should not be wasted on animals of doubtful value. Butcher the "boarders" and concentrate on the profitable cows. The added attention bestowed upon the good animals will be more than repaid by the results.

HERD MANAGEMENT.

Three principal lines of treatment are employed in combating abortion. First, herd management, including control of breeding, plays an important part. It has been the practice of some owners to sell all aborting cows. This practice is not only economically wrong, but it does not serve to eradicate the disease. It has been pointed out that there is a tendency toward immunity, and more than half of the affected cows do not abort a second time. It would seem the part of wisdom, then, to keep the aborting cow, provided she is otherwise profitable enough to warrant the added expense, and by proper treatment to restore her to usefulness. Such a cow, having acquired immunity, would be more valuable in an infected herd than a susceptible animal, which would in turn abort. Moreover, when a man sells a cow he is often under the necessity of replacing her, and if he purchases from a clean herd the new cow will be susceptible. He has not eliminated the infection from his herd or premises, and consequently the newcomer will contract the disease. It has been demonstrated that thus to introduce susceptible animals into an infected herd is one means of perpetuating the disease. If, on the other hand, he purchases animals of unknown origin, he may be buying some other man's aborters, or animals that for some reason are less valuable than his own, and he is no better off than before. It is becoming increasingly difficult to purchase good breeding animals, and in view of the foregoing facts an owner should hesitate to dispose of a valuable animal because she aborts. Unless the aborting cow is sent to slaughter she is purchased by some unsuspecting person and may be the means of introducing a contagious disease into one more herd. This may be considered smart practice by some, but it is of course dishonest. Already laws are contemplated for the suppression of this abuse, which is having a disastrous effect.

It is sometimes necessary to introduce new blood for the purpose of building up a herd, the owner of pure breds desiring new blood lines and the owner of grades wishing to grade up his herd by the use of registered sires. It is unsafe to purchase mature animals, unless the purchaser can be sure that they are free from disease. A better practice is to purchase the new animals as calves, whether male or female, and raise them in an environment where there is no possibility of contamination.

Great care should be used in purchasing cattle, and cows not known to be free from the disease should be kept in separate quarters until this point is determined. If a herd bull is not kept, then great care should be exercised to know that the animal used to serve the cows is free from disease and to see that he is properly treated, as hereinafter recommended, both before and after service.

It is assumed that owners desire to improve their herds. That being the case, the calves are the most valuable product of the herd, as improvement comes only through selection of the offspring of the best individuals properly mated. There is another reason for retaining the calves. Recent observations seem to indicate that calves born in affected herds and raised in that environment have a tolerance for the disease and are less liable to abort than heifers from free herds. This has been shown in the case of one large herd which has been under observation by the Bureau of Animal Industry for more than nine years. During the years that the herd was being replenished by purchase abortions were frequent, but that practice was discontinued, and the heifer calves born in the herd have been raised. Since that time abortions have progressively decreased, until at present losses have practically been eliminated, although some of the cows continue to react to the tests. Thus a herd immunity seems to have developed as the result both of keeping the aborting cows and raising the calves. Therefore it seems safest for a herd owner to raise his own calves and avoid bringing in new infection.

The proper handling of cows in advanced pregnancy plays an important part in the production of healthy calves. The cow should be withdrawn from the herd about one month before calving, and placed in light, clean, comfortable quarters. Every well-equipped establishment should have a maternity stable built to suit the size of the herd. It should be constructed of material—preferably cement—that will permit of thorough disinfection, and should have the maximum of sunlight and adequate ventilation. Individual box stalls are desirable. The stalls should be thoroughly disinfected and whitewashed before use, and thereafter kept bedded with clean straw. Some authorities recommend that an antiseptic bath be given the cow before she is placed in the new quarters, and in addition they douche the vagina two or three times a week with mild, nonirritating antiseptics. This practice, if consistently followed, will tend to prevent the diseases of young calves, such as white scours and calf pneumonia, and will repay for the effort expended in valuable calves saved. The feeding of the pregnant animal is also important. Constipation at this time should be avoided, and laxative feeds, such as bran, oil meal, silage, roots, or other succulent feed should be given.

The isolation of aborting animals is a feature of herd management which is of the utmost importance. The aborting cow contaminates with her discharges the stable or the pasture, and the infection is then transmitted to the healthy cows in various ways. Removing the discharging cow minimizes the chances of infection for the susceptible animals. Isolation does not mean neglect. The isolated cow should receive prompt, thorough, and intelligent treatment if she is to regain her usefulness. Experience has shown that sterility may often be prevented by this course.

Whenever it becomes necessary to separate diseased and healthy animals, it is important that precautions be taken to prevent carrying infection, on clothing or shoes, from the diseased to the healthy cows. If it is not practicable to provide a special attendant, then by putting on rubber boots and a linen duster, or suit of overalls which can be kept clean, and are removed as soon as the special work has been finished, it would be possible to avoid spreading the disease. The boots should be washed with strong antiseptic on leaving the inclosure. The isolated cows should be attended to only after the work with the healthy animals has been completed.

DISINFECTION OF PREMISES.

A second line of prevention consists of the disinfection of premises. It is one of the best known of all facts connected with preventive medicine that dark, damp, poorly ventilated buildings in which filth, dust, and litter have been allowed to accumulate, harbor, and transmit the germs of contagious diseases. On the other hand, stables so constructed that filth can not accumulate, that are well drained, well ventilated, and flooded with sunlight, seldom act as breeding places for disease. Proper construction, then, is of considerable importance in maintaining a healthy herd.

Chemical disinfectants are also used to good advantage in controlling disease. The following directions for their use are given:

1. Sweep ceilings, side walls, stall partitions, floors, and other surfaces until they are free from cobwebs and dust.

2. Remove all accumulations of filth by scraping. If woodwork has become decayed, porous, or absorbent is should be removed, burned, and replaced with new material.

3. If the floor is of earth remove 4 inches from the surface, and in places where it shows staining with urine a sufficient depth should be removed to expose fresh earth. All earth removed should be replaced with earth from an uncontaminated source, or a new floor of concrete may be laid, which is very durable and easily cleaned.

4. The entire interior of the stable, especially the feeding troughs and drains, as well as milking stools and all other implements, should be saturated with a disinfectant, as liquor cresolis compositus (U. S.

P.) or carbolic acid, 6 ounces to every gallon of water in each case. After this has dried, the stalls, walls, and ceilings may be covered with whitewash (lime wash), to each gallon of which should be added 4 ounces of chlorid of lime.

5. All refuse and material from the stable and the barnyard should be removed to a place not accessible to cattle or hogs. The manure should be spread on fields and turned under. In addition the yards should be disinfected by sprinkling liberally with a solution of copper sulphate, 5 ounces to a gallon of water.

The best method of applying the disinfectant and the lime wash is by means of a strong spray pump, such as is used by orchardists. This method is efficient in disinfecting against most of the contagious and infectious diseases of animals, and should be applied immediately following any outbreak, and as a matter of precaution it may be used once or twice yearly.

6. It is important that arrangements be made to admit a plentiful supply of sunlight and fresh air by providing an ample number of windows, thereby eliminating dampness, stuffiness, bad odor, and other insanitary conditions. Good drainage is also very necessary.

TREATMENT OF THE BULL.

Another line of treatment, but not least in importance, is the treatment of the individual animal.

To prevent the bull from carrying the infection from a diseased cow to a healthy one, first clip the tuft of long hair from the opening of the sheath, then disinfect the penis and sheath with a solution of ¼ to ½ per cent of liquor cresolis compositus, lysol, or 1 per cent carbolic acid,[1] or 1 part to 1,000 potassium permanganate in warm water. The only apparatus necessary for the disinfection is a soft rubber tube five-eighths inch in diameter and 5 feet long, with a large funnel attached to one end; or an ordinary fountain syringe and tube would serve the purpose. If large numbers of animals are to be treated a bucket can be fitted with a small faucet to which the tube is attached. This can be suspended from the ceiling or from the rail of the litter carrier. The tube should be inserted into the sheath and the foreskin held with the hand to prevent the immediate escape of the fluid. If a funnel is used elevate it as high as possible and pour in the fluid until the preputial sac is filled. In addition to this the hair of the belly and inner sides of the thighs should be sponged with antiseptic of twice the strength. This disinfection should invariably precede and follow every service.

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[1] Two tablespoonfuls of fluid equal 1 ounce; therefore this amount of antiseptic added to 6 pints of boiled water will make approximately a 1 per cent solution.

TREATMENT OF THE COW.

An aborting cow should receive immediate attention and should be removed to separate quarters where she can receive appropriate treatment. The fetus, membranes, and discharges are particularly dangerous and should be gathered up and destroyed immediately by burning or burial in some safe place, and this followed by thoroughly disinfecting the stall. The uterus should be irrigated daily with one of the antiseptics mentioned for the bull. using the same apparatus, and irrigation should be continued until discharge ceases. Lugol's solution[1] in a strength of 2 per cent has been found to be desirable as a uterine douche. It is not permitted to remain in the uterus but is flushed out with salt solution.[2]

The action of the antiseptic should be noted, and if it causes straining or irritates the tender membranes of the genital organs a less irritating or a weaker solution should be used. In addition the external genitals, the root of the tail, the escutcheon, etc., should be sponged daily with a solution twice as strong as that used for irrigation, and this latter treatment should be given the nonaborters as well.

Should the preliminary symptoms of abortion be detected, the animal should be removed from the herd and treated as above prescribed.

Retention of the afterbirth is a serious matter. The afterbirth should not be forcibly removed, as the lining membranes of the uterus would be torn and a point of entry thus provided for the germs which cause blood poisoning. The uterus is very susceptible to this form of infection at such times, and injury should be carefully avoided. Clumsy and forcible manipulation of the parts may cause infection and death of the animal. The best practice is to flush the uterus twice daily with a mild antiseptic to prevent the accumulation and absorption of poisonous products, and allow the membranes to come away of themselves. Such a case usually calls for skillful treatment and should be entrusted to a competent veterinarian. In all these manipulations hands and utensils should first be thoroughly disinfected.

After abortion, breeding should not again be attempted within two months, or until the discharge shall have ceased, as the uterus would not be normal and the animal either would not conceive or would abort again in a short time.

It is recognized that to carry out the foregoing recommendations will involve much labor and attention to detail, but they offer the system which up to the present time has been of the most practical use. This system has the additional advantage that the careful attention to sanitation and control of breeding operates to prevent the introduction and dissemination of other infectious diseases.

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[1] Lugol's solution of iodin is compounded as follows: Iodin 5 parts, potassium iodid 10 parts, and boiled water to make 100 parts. Two parts of this compound in 100 parts of boiled water make a solution suitable for uterine irrigation. Lugol's solution may be purchased from druggists.

[2] A 1 per cent solution of common salt in boiled water at body temperature makes a suitable irrigating fluid. A heaping tablespoonful of dry salt weighs approximately 1 ounce, and this amount in 1 gallon gives the proper strength.

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Dup

TURKEY RAISING

ANDREW S. WEIANT
Animal Husbandry Division

FARMERS' BULLETIN 791

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
A. D. MELVIN, Chief

Washington, D. C. March, 1917

TURKEY RAISING, as ordinarily engaged in, is a side line upon the general farm. For those who are favorably situated for raising turkeys, a more profitable side line can hardly be found. Plenty of range is essential to success.

The most widely known turkey is the Bronze, after which come the White Holland, the Bourbon Red, the Black, the Narragansett, and the Slate.

One of the most important steps toward success in turkey raising is the proper selection of breeding stock. Birds for breeding should be selected for vigor, size, shape, strong bone, early maturity, and color of plumage.

Turkey hens will usually lay about 18 eggs in their first litter, while those that do not have to be set can be broken up on becoming broody and made to lay a second and sometimes a third litter.

The high mortality common in young poults is usually due to some of the following causes: Exposure to dampness and cold; improper feeding; close confinement; lice; predatory animals; weakness in the parent stock.

During the summer and early fall turkeys can find an abundance of feed on the average farm. About October 1 it is advisable to begin fattening them for market, giving only a little feed at first and gradually increasing this until the birds are marketed. The marketing season for turkeys is very short, running only from the middle of November to the latter part of December.

Of the infectious diseases of turkeys, blackhead is the most destructive. It is notable that whenever the climate and range conditions are such as to permit of the turkeys foraging for most of their feed from the time they are hatched until they are marketed, cases of blackhead are infrequent. No positive cure for blackhead has been found, but free range and care not to overfeed are very important factors in raising turkeys successfully.

TURKEY RAISING.

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THE TURKEY INDUSTRY IN THE UNITED STATES.

TURKEY RAISING, as ordinarily engaged in, is a side line upon the general farm. Throughout the Middle West, where most of the turkeys are raised, it is unusual to see a flock of more than 50 on any farm, although in Texas, where more are produced than in any other State, flocks of several hundred are rather common. In sections of the Southwest and on the Pacific coast a few persons have engaged in turkey raising on a large scale, raising a thousand or more every year. There are not, however, turkeys enough raised on the Pacific coast to supply the local demand; this is true also of the Atlantic Coast States. The production in New England, once famous for its turkeys, is very greatly reduced.

For several reasons the number of turkeys in the United States is decreasing. According to the census of 1900 there were in the United States at that time 6,594,695 turkeys, while by 1910 the number had decreased to 3,688,708. Poultry dealers throughout the country state that the decrease has continued ever since the last census. The principal cause of the decrease is that as the population of the country increases farming becomes more intensive, and every year the area of range

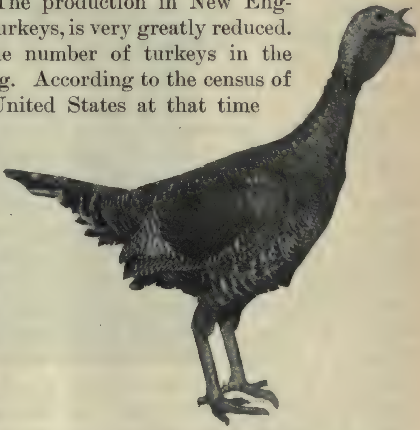

FIG. 1.—Bronze turkey hen. (The male is shown on the title page.)

suitable for turkey raising is reduced. Many turkey raisers have given up the business principally because their turkeys range through the grain fields of adjacent farms and thus cause the ill will of the owners thereof. Furthermore, the high mortality among young poults as ordinarily cared for on the farm, the outbreaks of disease, particularly of blackhead, among the turkeys in certain sections of the country, together with serious losses resulting from the presence of predatory animals in other sections, have tended greatly to discourage the turkey industry.

PROFITS FROM TURKEY RAISING.

For those who are favorably situated for raising turkeys a more profitable side line can hardly be found. Given plenty of range, turkeys will readily find grasshoppers and other insects, green vegetation, the seeds of weeds and grasses, waste grain, and acorns and nuts of various kinds. In this way the cost of raising them is very small and the profits large. Grain and stock farms are particularly well adapted for turkey raising, and it is on such places that most of the turkeys are found. Plenty of range is essential to success in turkey raising. Little has ever been done in the way of raising turkeys in confinement, and when it has been tried the results have been discouraging.

The average price received by the producer for live turkeys ranges from about 12 cents a pound in Texas to 25 cents in parts of New England. During November and December, 1915, the price averaged about 13 cents in Tennessee, 13⅓ in Mississippi, 14½ in Missouri, 17 in Ohio, 20 in California, and 21 in New York.

VARIETIES.

All domestic varieties of turkeys are descended from wild turkeys originally found in North America from New England to Arizona and Florida and still found in the more unsettled sections of their former range, particularly in the mountainous parts of Texas, New Mexico, and Arizona, and in the large swamps and hummocks of the Gulf States. Wild turkeys differ somewhat in color, the extreme of which is shown by the Mexican wild turkey found in Arizona, New Mexico, western Texas, and northern Mexico, and the common wild turkey (fig. 7), found in the eastern part of the United States. These two varieties differ in that the eastern turkey is of a brilliant copperish bronze, with the tips of the tail coverts and main tail feathers yellowish-brown, while the Mexican turkey is of a darker color, the bronze being shaded with black and the tips of the tail coverts and main tail feathers white.

Another species of wild turkey, found in Central America and known as the Honduras turkey, is quite distinct from the North American species. This turkey is of beautiful plumage, the general color being bright green, shaded with blue, red, bronze, and black. It is somewhat smaller than the North American wild turkey and has never been domesticated to any great extent.

Six varieties of domestic turkeys are recognized by the American Standard of Perfection. Of these by far the most widely known is the Bronze (see illustration on title page and fig. 1), after which come the White Holland (fig. 2), the Bourbon Red (fig. 3), the Black (fig. 4), the Narragansett (fig. 5), and the Slate (fig. 6).

In color the Bronze turkey is of a rich, brilliant, copperish bronze against a background of black and brown and contrasted by the clear-white tips of the tail coverts and main tail feathers. When wild blood has been introduced, however, the tips of the tail feathers are yellowish brown rather than white. The Bourbon Red is of a deep brownish red, with white wings and tail. The White Holland is pure white. The Black turkey is of a lustrous greenish black throughout. The color of the Narragansett is steel gray against a background of black. The Slate turkey is of a slaty or ashy blue color, more or less dotted with black.[1]

By judicious breeding, turkeys have increased markedly in size since domestication. The wild turkeys of to-day average in weight about 12 pounds for young toms and 8 pounds for young hens, while the standard weight for the Bronze variety is 25 pounds for young toms and 16 pounds for young hens. As a matter of fact, however, in sections where little or no attempt has

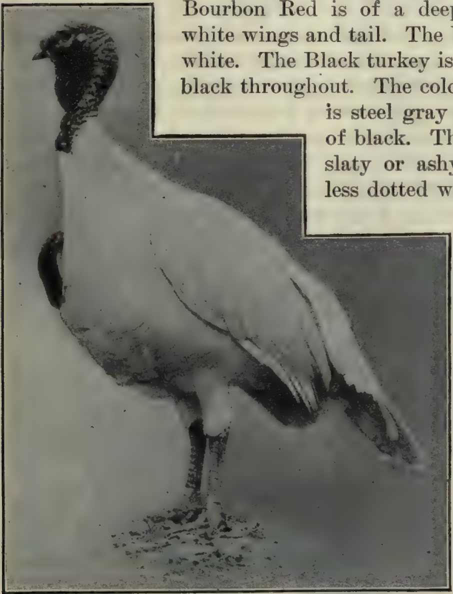

FIG. 2.—White Holland turkey, male.

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[1] For detailed description of the different varieties of turkeys, see the American Standard of Perfection, published by the American Poultry Association.

been made to breed turkeys up to a high standard the weight of the ordinary run of turkeys does not average more than that of the wild ones.

The standard weights of the different varieties of turkeys as given in the American Standard of Perfection are as follows:

Standard weights of turkeys.

Variety.	Adult cock (2 years old or over).	Yearling cock (1 year old and less than 2).	Cockerel (less than 1 year old).	Hen (1 year old or over).	Pullet (less than 1 year old).
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Bronze	36	33	25	20	16
Bourbon Red	30	25	20	18	12
Narragansett	30	25	20	18	12
White Holland	28	24	20	18	14
Black	27	22	18	18	12
Slate	27	22	18	18	12

SELECTION OF A VARIETY.

Owing to the fact that the Bronze turkey is the heaviest, it is more popular among turkey raisers than the other varieties. Since turkeys are sold by weight, the heaviest birds bring the greatest returns. When a large number of people are to be served, as in hotels, restaurants, and boarding houses, the demand is for heavy turkeys. For family use the demand is for small or medium-sized birds. Unless they are to be marketed locally among customers who demand small birds, it is far more profitable to raise the heaviest. Regarding other characteristics, it is quite generally asserted that the Bronze is the hardiest variety; that the Bourbon Red and White Holland are the most domestic; and that the White Holland is the most prolific. These qualities are possessed in different degrees by individuals of every variety, however, and can be developed by proper management and careful selection of breeding stock.

SELECTION OF BREEDING STOCK.

One of the most important steps toward success in turkey raising is the proper selection of breeding stock. Unhatchable eggs, weak poults, and

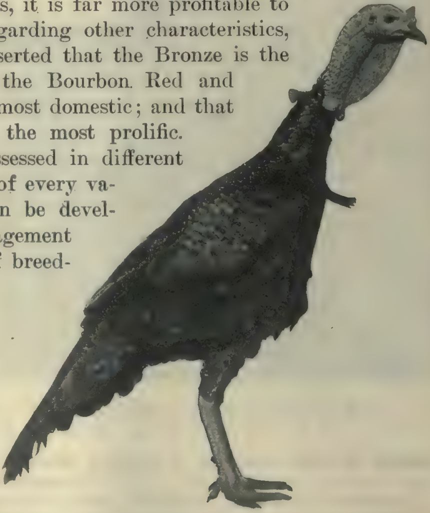

FIG. 3.—Black turkey, male.

small, scrubby turkeys are largely the result of carelessness in the selection of the parent stock. In selecting turkeys for breeding purposes, strength and vigor are the first points to be considered. To indicate this the body should be deep and wide, the back broad, and the breast round and full. The head should be of good size, and of a clean, healthy appearance. A strong, well-made frame is shown by thick, sturdy shanks and straight, strong toes.

Breeders of pure-bred turkeys select their breeding stock for vigor, size, shape, bone, early maturity, and color of plumage. It should be the aim of every turkey grower to have a flock of pure-bred turkeys, even though they are sold at market prices. The cost of raising pure breds is no more than that of mongrels, and the profit is much greater. By all means the male at the head of the flock should be a pure-bred bird of the best type obtainable. He is one-half the entire flock, and by continually selecting the best females of a similar type and mating them with a pure-bred male one can soon have a flock of uniformly large, early maturing, strong-boned, long and deep-bodied turkeys of the same color that will bring better prices on the market than mongrels, because they will be of greater size and better fleshing qualities. Aside from the greater market value of pure-bred turkeys there is also an excellent opportunity of selling the best birds for breeding stock at increased prices. The demand for pure-bred turkeys is good and as soon as their reputation is established breeders of high-class birds have little difficulty in disposing of them.

Inbreeding is harmful and if carried on very long will result in the loss of vigor and vitality. It is therefore advisable each year to obtain a new tom of unrelated blood, but of the same type. Nothing is to be gained by crossing varieties, as such practice soon reduces pure breds to mongrels.

As to the best age for breeding stock, most turkey breeders prefer to mate a vigorous, well-grown young tom (cockerel) with early hatched young hens (pullets) or with yearling hens. Early hatched turkeys are in most cases sufficiently mature to be used as breeders their first season, but in no case should late-hatched or slow-growing birds be kept for breeders. An excellent plan is to keep as breeders each year one-half yearling hens and one-half early

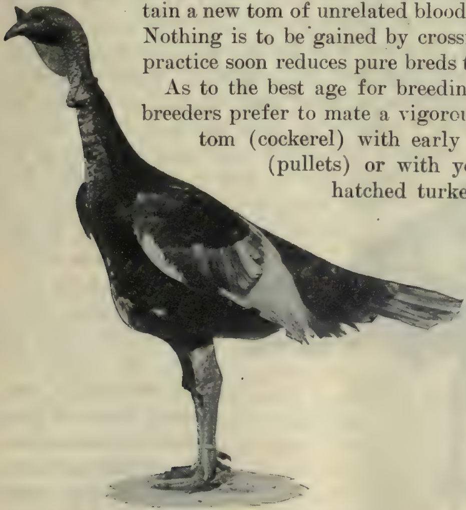

FIG. 4.—Bourbon Red turkey, male.

hatched pullets, and mate them with a well-developed and vigorous early hatched cockerel. Yearling toms can be used if desired, but, owing to their greater weight and clumsiness, they are liable to injure the hens. Should a yearling or older tom be used, care should be taken to pare off the spurs and file the sharp points from the nails. After the third year the egg production of turkey hens begins to fall off and it is advisable to replace them with younger stock.

The most satisfactory time of year to select breeding stock is November or December. By purchasing early in the season one not only has a larger number to choose from, but the birds are given ample time to become acquainted with their new surroundings before the mating season, which in the South ordinarily begins early in February and in the North about a month later.

MANAGEMENT OF BREEDING STOCK.

Fifteen turkey hens can safely be mated to a vigorous tom. If 25 or 30 hens are kept, two toms should not be allowed to run with them at the same time, but one should be confined one day and the other the next. When two toms are allowed to run together during the mating season, they fight fiercely, and the stronger does practically all the mating.

When only a few turkeys are kept it is the usual custom to allow them free range throughout the breeding and laying season. This is undoubtedly a good plan, provided the nests are found and the eggs gathered daily, if there is danger of their being destroyed or chilled. If many turkeys are kept, however, it is usually found most convenient to use breeding pens or inclosures. These should be of sufficient size to afford some exercise, an acre for 15 turkey hens being none too large. By taking turns in the use of three toms, as many as 45 turkeys may be kept in one inclosure, one tom being used every third day, or, better yet, one can be used in the morning, another in the afternoon, and a third the following morning. It is an excellent plan to allow the birds to roost outside the pen, turning them out late in the afternoon, after they are through laying, and driving them in early the following

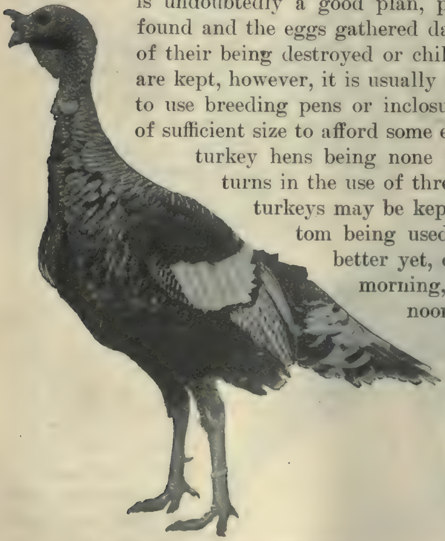

FIG. 5.—Narragansett turkey, male.

morning. Turkeys are easily handled, the work of driving them into the pen every morning requiring but a few minutes if they are fed there regularly, and the exercise they get while ranging outside the pen helps to keep them in good condition.

The construction of a turkey pen is simple. Very often the family orchard is utilized for this purpose. A hog-proof wire fence 3 feet high (fig. 9) will hold most turkeys if the pen is large enough to keep them contented and if the hens are put into the pen before they have selected nesting places outside. Should any persist in flying out the flight feathers from one wing can be cut or a paddle fastened across the back by tying with a strip of cloth under each wing, so that when the wings are raised they strike against the paddle and flight is prevented (see fig. 10). Turkey hens that have made their nests before they are put into the pen will make every effort to get out whenever they want to lay, and if they do not succeed they will often hold the first egg or two as long as possible and then lay wherever they happen to be. Within two or three days, however, they usually select a nest in the pen and there lay the remainder of the litter.

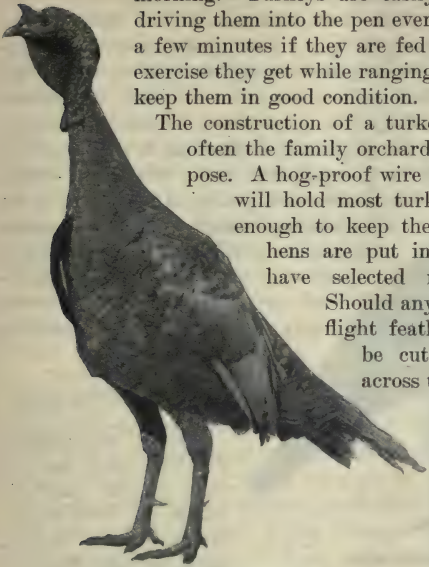

FIG. 6.—Slate turkey, male.

Rail, board, or stone fences are of no value for confining turkeys, which easily fly on top of them and then jump down on the other side. In the case of a wire fence, however, there is no place on which to alight, and under ordinary circumstances they do not make the attempt. For this reason steel posts are better than wooden posts for a turkey fence unless the latter are sharpened at the tops.

FEEDING THE BREEDING STOCK.

Good breeding condition means being well fleshed, but not fat. Given free range where there is ample supply of natural feed during the winter and early spring, such as is usually the case in the southern portion of the United States, a good daily feed of grain, preferably oats or wheat, is sufficient to keep the birds in good condition. The natural feed of turkeys at this time of the year consists largely of grass, tender buds, young leaves, insects, and nuts and seeds of various kinds. During the winter northern turkey raisers usually feed twice a day on equal parts of oats, wheat, and corn, with vegetables such as potatoes, turnips, beets, and cabbage as a substitute for green feed. Animal feed at that time of year is essential to the best results, and can be supplied by feeding meat scrap, beef livers and lungs, or skimmed milk, either sweet or sour. If confined in a breeding pen, green feed can be supplied by sowing the pen to grass, oats, wheat, barley, clover, alfalfa, or some such crop. Wheat and hulled oats are the best grains to feed, corn being too fattening unless fed in connection with other grains. Free access to grit, charcoal, and shell-forming material, such as oyster shells, is necessary throughout the breeding and laying season.

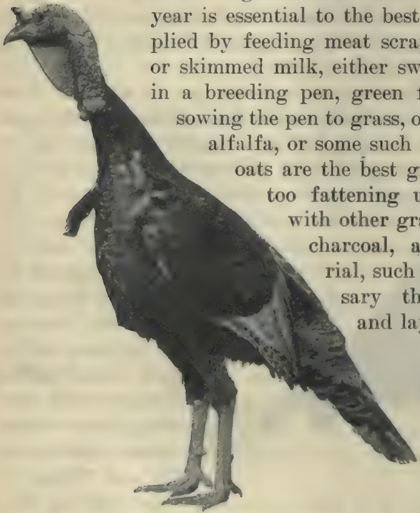

FIG. 7.—Wild turkey, male.

HOUSING BREEDING STOCK.

During cold winter weather, such as prevails in the northern States, a few turkey raisers provide roosting sheds, but the great majority allow their turkeys to roost in the open, usually in trees, throughout the year. There is little need of a regular turkey house, but during damp, icy weather and during stormy winds the turkeys should be driven into a barn or shed. They can stand a reasonable degree of dry cold, but they should not be exposed to dampness and cold at the same time.

LAYING.

Soon after mating turkey hens begin to look for nesting places and usually commence laying in from a week to 10 days after the first mating. One mating is sufficient to fertilize all the eggs of one litter, but the hens ordinarily mate 3 or 4 times before beginning to lay. All turkey hens, of course, do not begin laying at the same time, and in a flock of about 15 it may be 6 weeks or more from the time the first hen begins to lay until the last begins. Pullets usually commence laying a little earlier than yearlings or older hens. The average number of eggs in the first litter is about 18, although in individual hens it may vary from 12 to 30. Hens that do not have to be set can be broken up on becoming broody and made to lay a second or a third litter. The number of eggs laid in the second litter averages about 12, and in the third about 10, although there is considerable variation in the egg production of different hens. Some turkey hens can be made to lay 4 or 5 litters, but this is not usually advisable, as poults hatched later than June do not have a chance to develop for the Thanksgiving and Christmas markets and are not sufficiently mature by the following spring to be used as breeders. A hen that begins laying in the middle of March will usually finish laying her first litter early in April, her second litter late in April, and her third litter about the third week in May, depending upon the number of eggs she lays and the promptness with which she is broken up on becoming broody. Hens that are allowed to hatch and raise a brood of poults after laying their first litter often begin laying again in the fall, but poults hatched at that time are of little value, as they require too much care and attention to carry them through the winter. Fall-hatched pullets begin laying late the following spring, but they are immature at that time and poults hatched from their eggs do not develop into large, strong birds as do poults from mature stock.

Turkey hens can easily be broken of their broodiness by confining them for 2 or 3 days to a coop with a slat bottom. They will mate soon after being let out of the coop and begin laying in about a week. The first 2 or 3 eggs of a litter are usually laid at the rate of one every other day, after which the hens ordinarily lay every day until they are broody, although sometimes they skip one day before laying the last egg of a litter. There is no particular time of day when a turkey hen lays, but most of the eggs are laid in the morning. The following dates of laying and lengths of time remaining on the nest were obtained by watching a turkey hen during the laying season, and are typical:

Date.	Time of laying.	Time leaving nest.	Date.	Time of laying.	Time leaving nest.
Mar. 27	3.00 p. m.	4.00 p. m.	Apr. 6	9.00 a. m.	2.00 p. m.
Mar. 29	11.00 a. m.	1.00 p. m.	Apr. 7	9.00 a. m.	3.00 p. m.
Mar. 31	8.30 a. m.	10.00 a. m.	Apr. 8	10.00 a. m.	4.00 p. m.
Apr. 1	11.00 a. m.	1.00 p. m.	Apr. 9	10.30 a. m.	4.00 p. m.
Apr. 2	4.00 p. m.	5.00 p. m.	Apr. 10	10.00 a. m.	6.00 p. m.
Apr. 3	11.00 a. m.	12.30 p. m.	Apr. 11	10.00 a. m.	6.00 p. m.
Apr. 4	8.30 a. m.	9.30 a. m.	Apr. 12	[1] 7.30 a. m.	
Apr. 5	9.00 a. m.	3.00 p. m.	Apr. 14	([2])	

[1] Sitting.

[2] Date of laying last egg.

FIG. 8.—Breeding flock of Bronze turkeys on free range.

FINDING THE HIDDEN NEST.

Given free range, turkey hens usually secrete their nests in obscure places, such as patches of weeds, tall grass, or bushy thickets, and often wander a half-mile or more from home before they find places that suit them. To find these "stolen" nests (as they are usually termed) is often a long and tedious task, the usual method being to follow each turkey hen as she separates from the flock and starts toward her nest, taking care that she does not know she is observed. A much easier and quicker method than this is to confine the hens early some morning soon after they have come down from roost and let them out late in the afternoon. Those that are laying will then head straight for their nests in order to lay the eggs they have been holding.

If attractive nesting places are prepared about the barnyard, turkey hens sometimes lay in them. In the North, where the laying season often begins while there is still snow on the ground, they are more likely to select their nests near home than is the case in the South, as they do not range far during cold weather. Nests are easily made from boxes or barrels, or by scooping out a little earth in the shape of a shallow bowl and piling brush around it to satisfy the hen's desire for seclusion. Of all nests, however, the one most preferred by turkey hens is a barrel laid on its side and a nest shaped in it with straw or hay. When confined to a breeding pen several turkey hens often lay in the same nest, but on free range each hen usually makes her own nest.

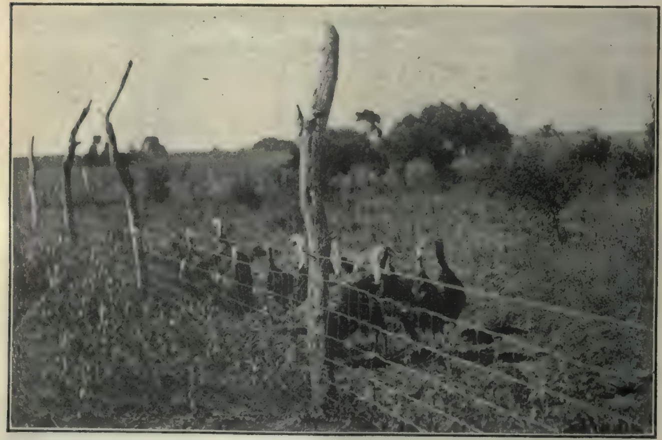

FIG. 9.—Breeding and laying pen or inclosure; hog-proof wire fence 3 feet in height.

CARE OF EGGS.

When there is danger that the eggs may be chilled or destroyed, they should be gathered every day and a nest egg left in each nest. Skunks, opossums, rats, crows, and dogs are the greatest destroyers of turkey eggs, although minks, raccoons, coyotes, wolves, foxes, cats, and certain large snakes are also egg eaters. Often, when a turkey hen has been disturbed by one of these pests, she changes her nest to some other place.

Eggs for hatching should be kept at a temperature of as near 50° or 60° F. as possible and should be turned over every day. They should be jarred as little as possible while handling and should be incubated while still fresh, never holding more than two weeks if it can be helped. It is an excellent plan to mark the date on each egg as it is gathered, in order to be certain that no eggs are kept too long before they are incubated.

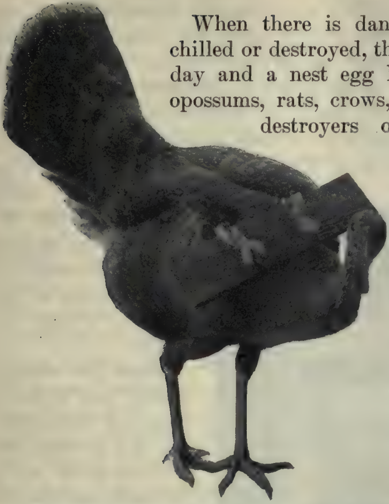

FIG. 10.—Paddle used to prevent turkey hens from flying over fence.

INCUBATION.

Turkey hens and chicken hens are ordinarily used to incubate turkey eggs, although incubators are quite generally used where turkeys are raised on a large scale. During the early part of the laying season it often happens that there are on hand a number of eggs that should be set before any of the turkey hens are through laying their first litter and become "broody." In such case and also, when it is desired to have the turkey hens lay a second or third litter, some of the eggs have to be incubated under chicken hens or in an incubator. About a week before the poults are to hatch a sufficient number of turkey hens should be allowed to sit to take all the poults hatched. They can be given a few eggs from the incubator or from under the chicken hens and allowed to hatch the poults themselves, or at night a newly hatched poult can be slipped under each turkey hen that is to be given a brood of poults and by morning they will take them.

Turkey hens are very close sitters, and if managed properly they are the surest means of hatching turkey eggs that can be used. Incubators, however, are quite as successful with turkey eggs as with chicken eggs. Poor hatches are a very frequent cause of complaint among turkey raisers, and this is quite often due to crowding more eggs under the hens than they can properly cover. One egg too many means that every egg in the nest will probably become chilled at some time during the four weeks of incubation. Turkey hens cover from 15 to 18 eggs and in some cases more, depending on the size of the hen. Chicken hens of the general-purpose breeds cover from 8 to 10 eggs. The turkey-egg capacity of an incubator is approximately three-fourths of the chicken-egg capacity.

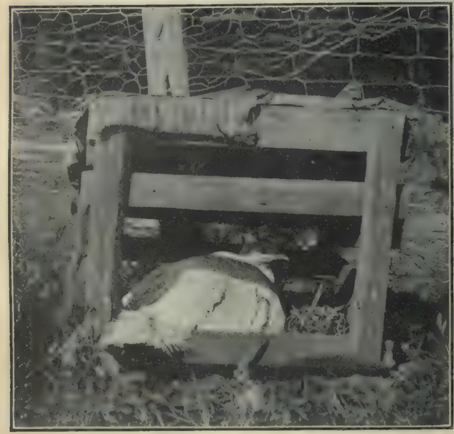

FIG. 11.—Coop used for turkey hen while sitting.

Nests for setting turkey and chicken hens are best made on the ground by hollowing out a little earth, so that the center is deep enough to keep the eggs from rolling out of the nest. A thin covering of clean straw or hay can then be used to prevent the eggs from being directly on the ground, and a large roomy coop should be placed over the nest to keep the hen from being disturbed (fig. 11). When a number of hens are to be set, a long row of nests (fig. 12) can easily be made on the ground, separating them with board partitions. If this is done care must be taken to see that when the hens come off the nests each returns to the right one instead of crowding into a nest with another hen and leaving some of the eggs to become chilled. With only a few hens it is better to set them some distance apart, as they will then require less attention.

When a hen becomes broody and shows that she is in earnest by remaining on her nest for two or three nights, she may safely be trusted with the eggs, provided she is allowed to sit in that nest. If she is to be set in another nest, as is usually the case, then she should be removed to the new nest, preferably after dark, given a few nest eggs, and shut in to prevent her from returning to the old one. If she sits quietly on the nest eggs she should be taken off on the evening of the following day and the eggs to be incubated placed in the nest. On being freed, she will probably return to her old nest; if so, she should be carried back and set quietly on the eggs, when she will immediately feel them beneath her and settle down to cover them. She should be handled in this manner until on being let off she returns to the new nest rather than to the old one. It sometimes takes but two or three days, and seldom more than a week, to break a hen from returning to her old nest. Turkey hens do not ordinarily come off for feed and water more than once every 2 or 3 days, but when confined they should be given an opportunity to come off every day. Occasionally a turkey hen does not come off at all, and in such case she should be taken off once a day, as otherwise she will die on the nest.

On coming off her nest the first thing a turkey hen does is to stretch her wings, step gingerly for a few steps, and then she often takes a running start and flies for a short distance. Exercise of this sort helps greatly to keep a sitting hen in good condition, and for this reason it is not well to confine her to a small space. A dust bath is greatly enjoyed by sitting hens and helps to keep them free from vermin. Whole corn is a good feed, and fresh water and grit should always be accessible.

Lice are a great annoyance to sitting hens and are one of the worst enemies of young poults. To prevent their getting a foothold, the hen should be dusted thoroughly with some good lice powder before she is placed on the nest, and then both the hen and nest should be similarly treated once a week for the first three weeks of the incubation period. The nesting material should be kept clean, and if the eggs become dirty they should be washed with a soft cloth dipped in lukewarm water. Just before the poults are to hatch, the old nesting material should be replaced with clean straw.

The incubation period of turkey eggs is 28 days. The first egg is usually pipped during the first part of the twenty-seventh day,

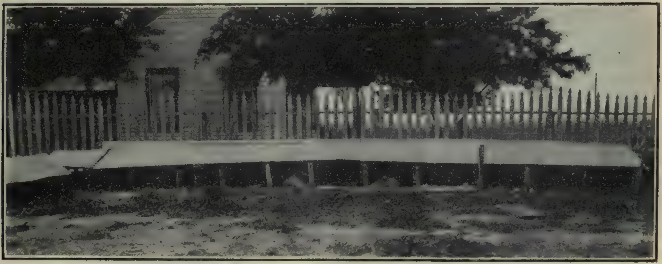

FIG. 12.—Long row of nests used by large turkey raisers for setting turkey hens.

the first poult hatched by the middle of that day, and the hatch completed at the end of 28 days, although in extreme cases all the poults are not hatched before the end of 30 days. Turkey eggs are tested for fertility and for dead germs, as a rule, on the tenth and twentieth days.

BROODING.

The average number of poults raised under ordinary conditions is about 50 per cent of those hatched out, or about 7 poults for every turkey hen. By far the greater part of this loss occurs when the poults are quite young, that is, under a week old. Seldom are any lost after they are a month old, unless there is an outbreak of disease. The high mortality amoung young poults is mainly from the following causes:

(1) Exposure to dampness and cold.
(2) Improper feeding.
(3) Close confinement.
(4) Lice.
(5) Predatory animals.
(6) Inherent weakness, the result of carelessness in selection of parent stock.

With the exception of predatory animals all these causes are easily removed. Experienced and careful turkey growers are able to raise a much higher per cent of the poults hatched.

As soon as the hatch is completed and the poults begin to run around outside the nest the hen and brood are ready to be removed to the coop provided for them. The coop should be built to keep out rain; it should be well ventilated, capable of easy movement, and be sufficiently roomy for a turkey hen to stand erect and walk about (fig. 13). There should be a separate coop for each hen and brood, and the coops should be scattered about the farm in such places as are easily drained and where natural feed, such as tender, green vegetation (grass, clover, alfalfa, and other green feed), and insects, particularly grasshoppers, can be found. By moving the coop every day the ground will be kept clean and opportunity will be given the mother hen and poults to pick up fresh, green feed inside the coop. Plenty of exercise is essential if the poults are to thrive. At all times, when rain or dampness does not prevent, the poults should be allowed to run in and out of the coop at will. Too much stress can not be given to the necessity of exercise, and the only way to provide for this is to allow the poults at every possible opportunity to range for feed outside the coop. During a long-continued rainy season it is better to allow them to run out of the coop whenever it is not actually raining, even though the grass is somewhat damp. By confining the mother hen to the coop she will always be ready to hover the poults whenever they run to her, which they will do if they become chilled. The greatest care should be taken to keep the interior of the coop dry, and for this reason it is advisable to choose a sandy slope where the water runs off quickly and where there is also protection from heavy rains. If necessary, the mother hen can be confined to a roomy coop for a week or more, provided she is properly fed and watered, and the coop moved to fresh ground every day.

If the weather is warm and dry, as frequently happens when the poults are hatched late in the season, no shelter is required, as they do better in the open: but it is advisable to keep them within a fenced inclosure for the first 3 or 4 days until they are strong enough to follow the mother. Weather conditions being favorable, the hen and brood can be given free range after the third or fourth day, but care should be taken to keep them out of heavy dews and to protect them from rain for the first 2 or 3 weeks. After this, early morning dews or light showers followed closely by warm sunshine will do little harm, as the poults soon become warm and dry. If cold, damp weather sets in, however, they will need to be kept in dry

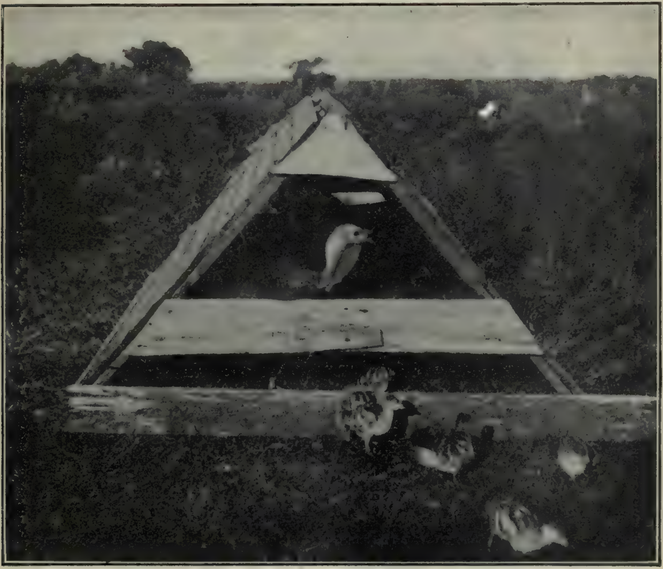

FIG. 13.—Turkey hen confined to a coop; the poults allowed to run in and out.

quarters, for nothing is more fatal to young poults than wet and cold.

THE TURKEY HEN AS A MOTHER.

For poults the turkey hen is the best mother that can be found. She knows their needs and can talk to them in a language that they soon learn to understand. At the approach of any danger she gives a low, warning note that sends them scurrying in every direction for a weed or patch of grass where they can lie flat on the ground safely hidden from view. While on free range, she keeps her brood together by talking continuously in a contented, purring tone so that the poults always know where she is. When her poults become widely separated, or if some become lost, and she hears their "peep, peep," she calls them with the characteristic yelp heard so frequently during the laying season. Now and then, while the poults are but a few days old, she catches a grasshopper and calls the poults to come and get it. They soon learn to find their own feed, however, and range out ahead of the mother hen in search of whatever they can find.

Young turkeys usually remain with the mother hen until about October or November, when the males ordinarily separate from the females and range by themselves. When two turkey hens with broods of about the same age are turned out on free range together they will remain in one flock, and as this makes it easier to hunt them up and care for them it is advisable to turn out 2 or 3 hens with their broods together when they are given free range. It is not a good plan to have more than this number of young poults in one flock, however, as they may all try to crowd under one or two hens to be hovered.

FEEDING THE POULTS.

Improper feeding, combined with close confinement, has been the cause of many failures in turkey raising. When on free range the poults are busy searching for feed most of the day. Here there is no overfeeding and lack of exercise, such as the poults are often subjected to by those ignorant of their wants. If the range is plentifully supplied with green feed, grasshoppers, and other insects, and if the weather is favorable, then the best plan is to allow the poults to feed themselves. It is usually advisable, however, to have them come home at night, and if driven up and fed at a certain place every night they will soon learn to come up themselves.

When, on account of rainy weather or unfavorable range conditions, it is advisable to raise the poults by the coop method, more care must be given to their feeding. For the first two days after hatching, poults require no feed, the yolk of the egg which they absorb before breaking out of the shell being sufficient to maintain them for that length of time. Access to clean drinking water and a little coarse sand and green feed to pick at is all that is needed until the third day. Beginning with the third day, the poults should be fed according to the quantity of natural feed they are able to pick up outside the coop. They should always be hungry. To feed all they will clean up several times a day removes the cause of searching for feed, so that little exercise is taken and indigestion is sure to result. When natural feed is scarce, or when the poults have to be kept from ranging outside, they should be fed lightly about five times a day. If allowed to run outside the coop where they can find insects, seeds, and green feed, they need not be fed oftener than two or three times a day.

Successful turkey raisers use many different kinds of feed, some of the most common being as follows:

(1) Hard-boiled egg chopped fine and corn-bread crumbs for the first week, and then whole wheat and hulled oats.

(2) Stale bread, soaked in milk and squeezed dry, for the first few days, and then common chick feed.

(3) Clabbered milk seasoned with salt and pepper, corn-bread crumbs.

(4) Equal parts "pinhead" oats, whole wheat, and cracked corn.

(5) Cracked wheat.

(6) Corn meal and wheat bran mixed in the proportion of 3 to 1 and baked into bread.

(7) Bran or middlings one-half, cracked Egyptian corn one-quarter, wheat and hulled oats one quarter.

In addition to the above, skimmed milk and buttermilk are quite often fed, with excellent results. A good plan is to keep the milk in front of the poults during the morning and water during the afternoon. If grit and green feed can not be picked up outside the coop, they must be provided in some other way. Chopped onion tops, lettuce leaves, dandelion leaves, and alfalfa make excellent green feed. Grit can be furnished in the form of coarse sand.

While confined to the coop the mother hen should be fed twice a day on a mixture of grain, such as equal parts corn, wheat, and oats, and green feed, while water and grit should be kept before her all the time. An occasional feed of meat scrap or fresh, lean meat is greatly relished and helps to keep her in good condition. In feeding the hen and poults, it is advisable to feed the latter outside the coop and the former inside, in order to prevent her from eating the feed intended for the poults. It is seldom necessary to keep the hen and poults confined for more than a few days at a time, and the sooner all can be given free range, the better. Whether or not they should be put into the coop at night after ranging during the day depends on the weather and the danger from predatory animals.

THE AGE AND SEX OF TURKEYS.

At the age of 4 weeks there is no trace of red on the heads and necks of the poults, but at 5 weeks the caruncles or comb begin to form, and when 6 weeks of age a trace of red can be seen forming in the caruncles under the feathery down of the neck; this down is gradually shed from the under part of the neck. At 7 weeks the red can be seen at some distance on the under part of the necks of males, but is not plainly visible on females until about the eighth week. It is only by careful comparison, however, that the sex of young turkeys can be distinguished before they are 3 months of age, at which time a very small, fleshy protuberance appears on the breast of the male, emerging from which the beard or tassel can be seen about 2 weeks later. At the age of about 3½ months the beard begins to grow from the breast of the male turkey and at 1 year of age it is from 3 to 5 inches long, becoming longer each year. When about a year old turkey hens begin to grow beards. The beard of the tom is much longer and coarser than that of the hen, however, and his feathers stop far down on the neck, while in the case of the hen there is a light growth extending in a rather narrow strip along the back of the neck to the top of the head. The "dewbill," or fleshy appendage just above the beak, is larger and more elastic in the male than in the female. Young toms under 1 year of age have only a short, blunt knob on the inside of the shank, which, as the bird grows older, develops into a stout spur, while in the hen only a rudimentary spur or small button is found.

REARING THE YOUNG TURKEYS.

When about 6 weeks old the young turkeys are old enough to go to roost. Practically all turkey raisers allow the birds to roost in the open trees or on fences or other roosts especially provided for them. In sections where high winds prevail it is customary to build the roosts next to a barn or shed, where there is some protection; when this is done posts are driven into the ground and poles laid across them 4 or 5 feet from the ground. By driving them to the roosting place and feeding them there every evening just before dark, young turkeys can be made to roost wherever desired. For the first few times it is sometimes necessary to keep them under the roost until dark, but they will finally fly up, and after a week or so will no longer have to be driven, but will come up every night to be fed and to roost.

During the summer and early fall turkeys can find an abundance of feed on the average farm. Grasshoppers and other insects, weeds and grass seeds, green vegetation, berries, and grain picked up in the fields all go to make up the turkey's daily ration. When this natural feed is plentiful, very little need be added until fattening time, except for the purpose of bringing the turkeys every night to roost and to keep them from straying from home. For this purpose one feed of grain every night just before roosting time is sufficient.

One of the greatest difficulties with which turkey growers have to contend is to keep their flocks from wandering over too wide an area and invading neighboring farms. To some extent, feeding heavily night and morning reduces the area over which turkeys range, but even then they often go too far. When trouble of this kind occurs, the most effective plan is to drive them into an inclosure, such as is described for a breeding pen, and keep them there until about noon. In warm weather turkeys do most of their ranging early in the morning and by 9 o'clock they are usually as far from home as they will get during the day. As soon as the sun becomes very warm they spend most of their time in the shade until 3 or 4 o'clock in the afternoon, when they begin moving toward home, ranging for feed along the way. If the weather is not too warm they do not spend so much time lying in the shade, and consequently range over a larger area and may keep moving away from home until noon. By feeding in the pen every morning they soon learn to go there on coming down from roost and no time is lost in penning them. If they fly out of the pen after being fed, the flight feathers from one wing should be clipped.

FATTENING FOR MARKET.

In fattening turkeys for the market an excellent plan is to begin about October 1 to feed night and morning, not feeding enough at a time but that the birds go away still feeling a little hungry, and gradually increasing the quantity until they are given all they will clean up three times a day during the week before marketing. By the latter feeding is meant that they are fed until they leave the feed and walk away. Some turkey raisers feed wheat and oats during the first part of the fattening season, gradually changing to corn as the weather becomes cooler. The majority, however, begin feeding heavily on corn about November 1, and since turkeys are not accustomed to such heavy feeding, scours often result, especially if new corn is used. New corn can be fed safely if the turkeys are gradually accustomed to it by feeding lightly at first and more heavily afterward.

Confining turkeys during the fattening season to prevent their using so much energy in ranging has been tried to some extent, but with very little success. Those confined to a pen eat heartily for 2 or 3 days, but after this they lose their appetite and begin to lose flesh rapidly. On allowing them free range again, they pick up rapidly and are soon eating as heartily as ever. The better method is to allow them free range, as it keeps them in good, healthy condition, and they are always eager to be fed.

Nuts of various kinds are a natural fattening feed picked up by the turkeys on the range. Of these beechnuts, chestnuts, pecans, and acorns are those most commonly found by them. Many turkey growers in Texas depend solely upon acorns for fattening their turkeys, and when the mast is plentiful the birds are marketed in fairly good condition.

CAPONIZING.

Turkey males are harder to fatten than the females, and they are especially hard to get in good market condition by Thanksgiving. Being much larger than the females, they require a great deal of feeding to cover their frames with thick layers of juicy meat, and in addition to this it is the nature of the young males to separate from the remainder of the flock about October or November and range over a wider area than the females. Very little has ever been done in the way of caponizing turkeys, but when it has been tried the capons were found to be much quieter in disposition and less liable to range over a wide area than the toms, and this character should be of considerable advantage in getting them in condition for the market.

MARKETING.

The marketing season for turkeys is very short, running from the middle of November to the latter part of December. Most turkey raisers sell their birds alive to poultry dealers, who either dress them or ship them alive to city dealers. Farmers near the city markets, and particularly those in the Middle Atlantic and New England States, often dress the turkeys and either sell them direct to the consumer or to city dealers. In some sections shortly before Thanksgiving there is held what is known as turkey day. On the day before this event every turkey grower in the neighborhood kills and dresses his turkeys and the following morning brings them into town, where they are bid on and purchased by whatever buyers choose to be there, the birds going to the highest bidder. (See fig. 14.)

In sections in which turkeys are grown in large numbers, as in Texas, dressing plants have been built by poultry dealers, who buy the birds alive and dress them for the various city markets. In such cases practically all the turkey raisers sell to these dealers, who often send buyers out into the country to gather up a drove of several hundred birds by stopping at each farm as they pass, weighing whatever turkeys the farmer may have to sell, and adding them to those already collected. Six or eight men can drive a flock of 1,000 turkeys 10 or 12 miles a day. This method of marketing is shown in figure 15. As soon as possible after the turkeys are received at the dressing plant they are killed, dry-picked, cooled, and packed in barrels or boxes for shipment.

In killing and dressing turkeys on the farm they should first be deprived of feed for 24 hours, but given plenty of fresh, clean water in order to clean the crop and intestines of all feed. When ready to kill, the bird should be hung up by the feet; holding the bird in one hand a sharp, narrow-bladed knife is used to sever the veins in the throat by making a small cut inside the mouth on the right side of the throat, at the base of the skull. After making this cut and bleeding begins, the knife is thrust up through the groove in the roof of the mouth and into the brain at the back part of the skull. On piercing the brain the bird gives a peculiar squawk, the feathers are loosened by a quivering of the muscles, and death is instantaneous. In dry picking the feathers should be plucked immediately, and if the bird has been properly stuck they come out very easily. The tail and large wing feathers are removed first, after which the body feathers are pulled out. When the turkeys are to be marketed locally

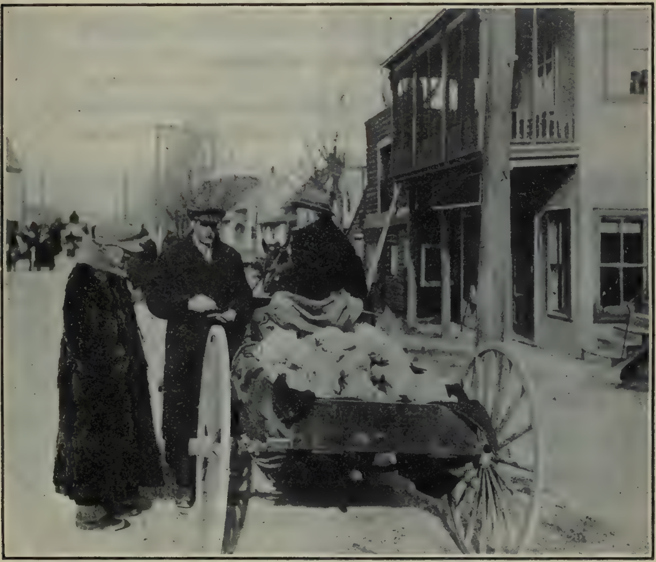

FIG. 14.—Marketing dressed turkeys on "turkey day" (Lisbon, N. Y.).

or are to be shipped but a short distance they are cooled to a temperature of about 35° F. by hanging in the open air, provided the weather is cool enough; otherwise they are plunged into ice water and kept there until thoroughly cooled. After cooling they are packed undrawn in boxes or barrels. It is inadvisable for the producer without proper refrigerating facilities to ship dressed turkeys, as losses from improper cooling and from their being exposed to warm weather during transit are liable to occur. Aside from this it is seldom profitable to ship turkeys any great distance except in carload lots; when this is done the turkeys are cooled to 32° F., packed in boxes or barrels, and shipped in refrigerator cars.

DISEASES OF TURKEYS.

Turkeys are subject to most of the diseases and ailments affecting fowls. Of these the most common diseases are blackhead, chicken pox (sore head), and roup. Limber neck and impaction of the crop are noninfectious ailments quite often found among turkeys.

FIG. 15.—Driving turkeys to market, Glasgow, Ky.

Of the parasites lice are the most injurious, especially among young turkeys, and unless some effective means has been taken to destroy them they can usually be found on every turkey in the flock.

BLACKHEAD.

Of the infectious diseases, blackhead is the most destructive among turkeys. This disease first became serious in the New England States many years ago; it is now found to a greater or less extent throughout the Middle West, and occasionally in the South and on the Pacific coast. It is notable that whenever the climate and range conditions are such as to permit of the turkeys foraging for most of their feed from the time they are hatched until they are marketed, cases of blackhead are infrequent. Blackhead occasionally affects grown turkeys, but it mostly occurs among young turkeys between the ages of 6 weeks and 4 months.

The symptoms of blackhead are such that unless the bird is killed and an examination of the internal organs made it is difficult to tell whether the disease is blackhead or some other ailment. The bird drinks a great deal, but refuses to eat and grows steadily weaker until its death, which usually occurs a few days or a week after the sickness is first noted. Diarrhea commonly occurs and the droppings vary in color from white to brown, but are usually a bright yellow. The head of the turkey sometimes turns dark and it is from this symptom that the name blackhead originated; this is an unfortunate term, as the head often does not turn dark, and even though it does it merely indicates that the bird is sick from some ailment that may or may not be blackhead. On opening a turkey that has died of blackhead, one or both of the ceca or "blind guts" are found to be enlarged and plugged with a cheesy material and the liver is more or less covered with spots varying in color from grayish white to yellow.

No positive cure for blackhead has been found. As in the case of all other infectious diseases, the sick bird should immediately be removed from the flock to prevent a further spread of the disease, and if very sick it is best to kill it and burn the body. Clean out the roosting place and spread lime in places most frequented by the turkeys. Keep a disinfectant in the drinking water; potassium permanganate is most often used, a sufficient quantity of the crystals being added to give the water a wine color, which, for every gallon of water, will take about as much of the chemical as can be placed on a dime. If the turkeys are being fed heavily, their ration should be reduced, as overfeeding predisposes to the disease. The feeding of sour milk has been found of advantage in keeping turkeys in good health and in reducing the activities of the organism causing blackhead. Free range and care not to overfeed are most important.

CHICKEN POX.

Chicken pox (sore head) is quite often found among turkeys, particularly when they are raised with fowls. It is characterized by scabby eruptions about the head and spreads quite rapidly from one bird to another. The affected birds should be removed from the flock, the scabs soaked off with warm water, and the sores washed with an antiseptic, such as a 2 per cent solution of carbolic acid or of potassium permanganate.

ROUP.

Roup is more common among fowls than among turkeys, but the latter are sometimes affected, particularly when they are exposed to drafts and dampness. The first symptoms of roup are those of a common cold, and later a swelling usually develops just below the eyes, giving rise to the name "swell head." Roup is very contagious, and any infected bird should be isolated and the mouth and nostrils washed out with an antiseptic; if there is a swelling under the eyes, it should be opened and the material that has formed there squeezed out; also, the cavity should be washed with an antiseptic.

In most cases it is advisable to kill any bird sick with anything of a contagious or infectious nature rather than to attempt treatment and run the risk of spreading the disease.

LICE.

Lice are among the most important causes of the high mortality among young poults, those badly infested becoming gradually weaker and weaker until they die. Head lice cause most of the trouble and are found close to the skin upon the top of the head, above and in front of the eyes and under the throat. Small white lice are also found along the wing bar among the quills of the feathers and occasionally are found below the vent. By dusting the hen when she is set with some good lice powder it is a very easy matter to prevent lice from getting a foothold among the poults. If this is not done, the poults are almost certain to have lice. The poults should be examined carefully every few days and if lice are found about the head a small quantity of lard should be rubbed over the affected parts. This kills the lice by closing their breathing pores. The lice found among the quill feathers along the wing bar and below the vent are more active than the head lice and do not remain so close to the skin. Should body lice be found, the poults should be dusted carefully under the wings and below the vent about once a week until the pests are exterminated.

LIMBER NECK.

Limber neck is characterized by a paralysis of the muscles of the neck, caused by the absorption of poison from the intestines. The presence of these poisons is usually due to eating decayed meat or moldy grain, or it may be attributed to indigestion or intestinal worms. A tablespoonful of castor oil to which 15 drops of oil of turpentine have been added should be administered.

IMPACTION OF THE CROP.

Impaction of the crop is caused by eating indigestible substances, such as feathers, and thus preventing the feed from passing through. The crop can usually be emptied by first giving a teaspoonful of sweet oil and then working the contents of the crop with the fingers up through the gullet and out of the mouth, the bird being held with its head down.

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Standard Varieties of Chickens. (Farmers' Bulletin 51.)
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Pheasant Raising in the United States. (Farmers' Bulletin 390.)
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Mites and Lice on Poultry. (Farmers' Bulletin 801.)

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Digestion Experiments with Poultry. (Bureau of Animal Industry Bulletin 56.) Price, 20 cents.
White Diarrhea of Chicks, with Notes on Coccidiosis in Birds. (Bureau of Animal Industry Circular 128.) Price, 5 cents.
A System of Poultry Accounting. (Bureau of Animal Industry Circular 176.) Price, 5 cents.

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HOW THE FEDERAL FARM LOAN ACT BENEFITS THE FARMER

C. W. THOMPSON

Specialist in Rural Organization

FARMERS' BULLETIN 792

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Office of Markets and Rural Organization
CHARLES J. BRAND, Chief

Washington, D. C. January, 1917

THE Federal land banks, it is expected, will stand ready at all times to lend money to farmers on farm-mortgage security. The interest charges will be not more than 6 per cent. There will be no excessive commissions or bonuses. Loans will be made for periods ranging from 5 to 40 years. Annual or semiannual installment payments on the principal will be required, and further optional payments on the principal will be permitted after a loan has run 5 years.

The local loan associations will improve the credit of their members and reduce the cost of loans through the performance of definite services.

The bonds issued will be secured not only by farm mortgages deposited with the land bank registrar but also by the capital and surplus of the 12 Federal land banks. Both mortgages and bonds will be exempt from all forms of taxation.

The Federal Farm Loan Board of the Treasury Department has general charge of the system. The Department of Agriculture will cooperate with this board in supplying information and rendering assistance to farmers who desire to take advantage of the Federal Farm Loan Act, especially with reference to the organization of local loan associations.

HOW THE FEDERAL FARM LOAN ACT [1] BENEFITS THE FARMER.

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INTRODUCTION.

THE Federal Farm Loan Act (approved July 17, 1916) makes provision for a system of 12 Federal land banks. Farmers desiring loans from such banks ordinarily will be required to become members of local national farm-loan associations.

The law also authorizes the organization of joint-stock land banks which may lend money directly to farmers. There is no assurance, however, that such joint-stock land banks will be organized in any given territory, because they are entirely dependent on private investors for their capital.

The organization of the Federal land banks without delay is assured, because the Federal Treasury will be drawn upon if necessary to raise the required capital. Every farmer in the United States will be included in the territory of one of the 12 Federal land banks, and every farmer, therefore, will have access to this system, provided he complies with the provisions of the law.

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[1] The general administration of the Federal Farm Loan Act is vested in the Federal Farm Loan Board of the Treasury Department. The membership of the board is as follows: William G. McAdoo, Secretary of the Treasury, chairman (ex officio); George W. Norris, Farm Loan Commissioner; Charles E. Lobdell; W. S. A. Smith; and Herbert Quick.

The Federal Farm Loan Act does not contemplate the lending of the Federal Government's cash or credit directly to the farmer. Such financial assistance as the Government gives merely guarantees the prompt establishment of the Federal land-bank system and its proper development and supervision.

With the aid of the mortgage banking facilities provided for in the act, it is believed that farmers generally will be relieved of many serious disadvantages to which they are subject under present conditions.

DISADVANTAGES UNDER THE PRESENT FARM-MORTGAGE LOAN SYSTEM.

The prevailing practice under the present farm-mortgage loan system in the United States involves certain disadvantages both to the borrower and to the lender. The borrower often pays excessive rates for interest and commission,[1] with additional charges for the abstract, for recording, etc. While interest rates may be relatively low in the more highly developed sections of the country, in these areas the borrower (even the man with well-established credit) is often forced in times of stringency to pay high rates for loans. The usual mortgage loan runs for a relatively short period of time, thus making it necessary to incur added expense for renewals. In many sections the borrower has no opportunity to pay off any part of his principal before maturity, and as a result the indebtedness remains undiminished to the end of the term.

The present system also subjects the lender to certain disadvantages which tend to prevent capital from seeking investment in farm-mortgage loans. Where a lender relies on his personal acquaintance with the conditions affecting such a loan he must have intimate knowledge of the farm mortgaged, must be assured of the validity of the land title, and must give attention to the upkeep of payments for taxes and insurance. He is often confronted with irregularity in the interest payments, due either to carelessness or to inability to pay on the part of the borrower. These considerations become all the more important in view of the fact that a considerable portion of the farm-mortgage loans in the United States are held by investors who exercise personal supervision with reference to their loans.

On the other hand, the investor who does not have a personal knowledge of the farm mortgaged to him and who must rely upon the representations of a third party is also subject to certain disadvantages. If he purchases the loan with some form of guaranty from a mortgage company or a mortgage bank, he must depend in the main upon the reliability of such mortgage company or bank, and while there are many such institutions that have established a reputation for reliability, the average investor is often in a position where he is not able to discriminate between those that make reliable representations and those that do not.

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[1] See United States Department of Agriculture Bulletin 384, Costs and Sources of Farm-Mortgage Loans in the United States. 1916.

Moreover, there are important considerations connected with the form of a mortgage loan which make it relatively less convenient to the investor who has access to standardized securities in the investment market. Many investors will be more interested in farm-mortgage securities issued in the form of bonds in convenient denominations, running for uniform periods of time, with convenient and reliable means for the collection of interest payments.

ADVANTAGES UNDER THE FEDERAL LAND-BANK SYSTEM.

The Federal land-bank system is designed to do away, as far as practicable, with the disadvantages of the present farm-mortgage system. No loan will be permitted under the new system at a rate of interest exceeding 6 per cent. The rate of interest charged the borrower must not exceed by more than 1 per cent the interest paid on bonds which the Federal land banks are authorized to issue. Eventually, the net profits made by a Federal land bank, after paying expenses and setting aside the required reserve, will be returned to the local national farm-loan associations, to be distributed among the borrowers after the deduction of the expenses and reserve requirements of the local associations. One advantage thus expected to result from the new system is a substantial lowering of interest rates to farmers. Not only is the interest rate limited to 6 per cent, but provision is also made so that the farmer will escape the annoyance and expense of bonuses and commissions. He will pay only such extra charges in connection with the making of a loan as are approved under the rules and regulations of the Federal Farm Loan Board.

The loans must be made for relatively long periods of time, running not less than 5 nor more than 40 years. Each loan must make provision for annual or semiannual payments on its principal, so calculated that the debt will be entirely paid at the end of the period. After a loan has run for 5 years the borrower is given the option of paying any additional sum on the principal, in multiples of $25, on any interest date. The following table shows the annual payments required on a loan of $1,000, running for a period of 20 years, with interest at 5, 5½, and 6 per cent.

Amortization table for a loan of $1,000, payable in 20 annual installments, with interest at 5, 5½, and 6 per cent.

Completed years.	Interest at 5 per cent.				Interest at 5½ per cent.				Interest at 6 per cent.			
	Payment.	Interest.	Applied on principal.	Principal still unpaid.	Payment.	Interest.	Applied on principal.	Principal still unpaid.	Payment.	Interest.	Applied on principal.	Principal still unpaid.
1	$80.24	$50.00	$30.24	$969.76	$83.68	$55.00	$28.68	$971.32	$87.18	$60.00	$27.18	$972.82
2	80.24	48.49	31.75	938.01	83.68	53.42	30.26	941.06	87.18	58.37	28.81	944.01
3	80.24	46.90	33.34	904.67	83.68	51.76	31.92	909.14	87.18	56.64	30.54	913.47
4	80.24	45.23	35.01	869.66	83.68	50.00	33.68	875.46	87.18	54.81	32.37	881.10
5	80.24	43.48	36.76	832.90	83.68	48.15	35.53	839.93	87.18	52.87	34.31	846.79
6	80.24	41.65	38.59	794.31	83.68	46.20	37.48	802.45	87.18	50.81	36.37	810.42
7	80.24	39.72	40.52	753.79	83.68	44.13	39.55	762.90	87.18	48.63	38.55	771.87
8	80.24	37.69	42.55	711.24	83.68	41.96	41.72	721.18	87.18	46.31	40.87	731.00
9	80.24	35.56	44.68	666.56	83.68	39.66	44.02	677.16	87.18	43.86	43.32	687.68
10	80.24	33.33	46.91	619.65	83.68	37.24	46.44	630.72	87.18	41.26	45.92	641.76
11	80.24	30.98	49.26	570.39	83.68	34.69	48.99	581.73	87.18	38.51	48.67	593.09
12	80.24	28.52	51.72	518.67	83.68	32.00	51.68	530.05	87.18	35.59	51.59	541.50
13	80.24	25.93	54.31	464.36	83.68	29.15	54.53	475.52	87.18	32.49	54.69	486.81
14	80.24	23.22	57.02	407.34	83.68	26.15	57.53	417.99	87.18	29.21	57.97	428.84
15	80.24	20.37	59.87	347.47	83.68	22.99	60.69	357.30	87.18	25.73	61.45	367.39
16	80.24	17.37	62.87	284.60	83.68	19.65	64.03	293.27	87.18	22.04	65.14	302.25
17	80.24	14.23	66.01	218.59	83.68	16.13	67.55	225.72	87.18	18.14	69.04	233.21
18	80.24	10.93	69.31	149.28	83.68	12.41	71.27	154.45	87.18	13.99	73.19	160.02
19	80.24	7.46	72.78	76.50	83.68	8.49	75.19	79.26	87.18	9.60	77.58	82.44
20	80.33	3.83	76.50	....	83.62	4.36	79.26	....	87.39	4.95	82.44	....
Total	1,604.89	604.89	1,000.00	....	1,673.54	673.54	1,000.00	....	1,743.81	743.81	1,000.00	....

The method of repaying loans described above has at least a twofold advantage. It encourages the borrower in habits of thrift through the requirement of a systematic plan of paying off his debt, and at the same time it makes possible the placing of the farmer's loan at a lower rate of interest, inasmuch as the gradual reduction of the principal constantly improves the security for the balance—

that is, while the security remains the same the debt which is based thereon is all the time growing smaller.

The Federal land-bank system also improves the farmer's security still further through the cooperative efforts of the members of the local loan associations, as explained in detail below.

THE IMPORTANCE OF THESE ADVANTAGES TO AMERICAN AGRICULTURE.

Loans of the character authorized under the act will in many cases assist tenants and other landless men in the purchase of farms, since a loan amounting to 50 per cent of the value of the farm may be obtained on conditions which make it possible for the borrower to repay the indebtedness out of the farm income. Many farmers will find it advantageous, by reason of the better terms offered, to borrow money under the new system in order to pay off their existing indebtedness. Other farmers will be enabled to make needed improvements which they have hesitated to undertake before on account of the difficulty of obtaining loans on acceptable terms.

HOW THE GRANTING OF LOANS IS SAFEGUARDED.

Under the Federal farm-loan system it is not proposed to extend credit except on the basis of proper security. To begin with, each loan must be approved by a loan committee of the local association. Inasmuch as every loan carries the indorsement of the local association, the members naturally will be careful in recommending loans to the land banks. The proper granting of loans is safeguarded further by the provision for a salaried appraiser in each land-bank district, appointed by the Government, who must approve every loan before it is made by the land bank.

HOW THE MARKETING OF THE LOANS IS IMPROVED.

In place of selling the actual mortgages, the Federal land banks are authorized to issue bonds secured by an assignment and pledge of the mortgages, in denominations of $25, $50, $100, $500, and $1,000. Because of the careful safeguards applied to these bonds they are expected to prove attractive to a large number of investors who desire to purchase reliable and convenient securities. In addition, it is believed that the bonds of small denominations will encourage saving and investment among individuals who have not heretofore been in the habit of making investments. Moreover, the bonds will be especially attractive because they, as well as the underlying mortgage securities, are exempt from all forms of taxation, as explained later.

WHO MAY OBTAIN LOANS FROM FEDERAL LAND BANKS.

Care has been taken to provide a system that does not give encouragement to speculative loans or to inflation in land values. All loans by Federal land banks are carefully restricted in the interests of general agricultural improvement.

In order to obtain a loan from a Federal land bank the borrower must agree to use the proceeds of the loan for one or more of certain objects specified in the act, namely, for the purchase of land for agricultural use; for equipment, fertilizers, and live stock for the land mortgaged; for buildings and other permanent improvements on said land; or, with certain limitations, for the payment of indebtedness. The borrower must furnish as security a first mortgage on farm land. The amount of the loan must be not less than $100 nor more than $10,000. The loan must not exceed 50 per cent of the appraised value of the farm land and 20 per cent of the value of the permanent improvements adequately insured. The borrower must be engaged, or about to be engaged, in the cultivation of the farm mortgaged. He will also be required, ordinarily, to become a member of a local national farm-loan association.[1]

HOW TO ORGANIZE A LOCAL NATIONAL FARM-LOAN ASSOCIATION.

At least 10 prospective borrowers are necessary in order to organize a local national farm-loan association, and the aggregate amount which they wish to borrow must be not less than $20,000. Every member is required by law to subscribe for shares of stock in the association ($5 shares) equal in amount to 5 per cent of his proposed loan. Each association must have a board of not less than five directors, which board elects a president, a vice president, a secretary-treasurer, and a loan committee of three members. These officers, except the secretary-treasurer, must be shareholders of the association.

The Federal Farm Loan Board will supply model forms for articles of association and by-laws, application blanks for loans, and other necessary papers. After the articles of association are signed by the members, they must be forwarded to the Federal land bank of the district. These articles of association must be accompanied by a written report of the loan committee, such committee previously having appraised the farm-land security offered by each member and having duly indicated its approval on the application blank of each member. The loan committee's report must also include an affidavit showing that each of the members of the association has fulfilled the various requirements under the law and under the rules of the Federal Farm Loan Board.

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[1] The law provides that if, because of peculiar conditions in a given locality, local associations are not organized after the act has been in effect one year, the board may authorize the land bank to make loans in such locality through approved agents, said agents to be either banks, trust companies, mortgage companies, or savings institutions.

The loan association is required to subscribe for shares of stock ($5 shares) in the Federal land bank equal in amount to its own shares of stock, and this subscription for stock in the Federal land bank must accompany the other papers.

After a Federal land bank has received such articles of association, with the accompanying affidavit and stock subscription, the directors of said Federal land bank are required by law to send an appraiser to investigate the solvency and character of the applicants and the value of their lands, and to determine whether in their judgment a charter should be granted to the association. If the decision of the directors of the land bank is unfavorable the charter will be refused; if their decision is favorable the charter will be granted by the Federal Farm Loan Board, unless good cause can be shown for refusing it.

HOW THE LOCAL FARM-LOAN ASSOCIATION ASSISTS THE FARMER TO OBTAIN BETTER CREDIT.

The local loan association does not lend money to its members. Its function is to perform certain services for them so that they may be able to obtain loans from the Federal land bank on better terms than now prevail. It is important that every borrower should understand what the services are which a loan association renders its members.

One important service, rendered through the loan committee, is an appraisal of the property offered as security by each borrower. While this is not the only appraisal considered by the Federal land bank in connection with an application for a loan, it serves as an important guide, corresponding to the appraisals supplied by local agents under the present mortgage system.

The loan association also renders an important service by transmitting the necessary papers and reports through its secretary-treasurer to the Federal land bank. Besides clerical work of this character and the transfer of funds to and from the Federal land bank, the secretary-treasurer is required by law to ascertain whether borrowers use the proceeds of their loans in the manner specified and to notify the Federal land bank of any irregularities in this respect.

While the loan association supplies many kinds of important information to the Federal land bank, as indicated above, it also contributes directly to the financial standing of the mortgage loans furnished to its members, in that the capital stock of the loan association carries a double liability which is added to the security represented by the members' mortgages. The local loan association is therefore to this extent a guaranty association for members' loans.

Still another important class of services will be rendered by the local loan association in accumulating investment capital. Each association is permitted to receive current deposits, giving therefor certificates bearing interest for not longer than one year, at not to exceed 4 per cent per annum, which certificates, when presented at the Federal land bank of the district in amounts of $25 or any multiple thereof, are convertible into land-bank bonds.

It may thus be seen that the local farm-loan association constitutes an important cooperative organization which directly assists in improving the members' credit by rendering certain services which otherwise would have to be performed by other agencies at added expense.

HOW THE FEDERAL LAND BANK ASSISTS THE FARMER TO OBTAIN BETTER CREDIT.

Each Federal land bank will be an institution upon which the farmers of the district can rely at all times as a source for mortgage loans, provided they comply with the provisions of the law. To this institution the farmer can turn for loans, not only in normal times when there is a relatively good opportunity for obtaining investment capital, but also in times of stringency when even the farmer with well-established credit often finds it difficult under present conditions to obtain suitable loan accommodations on reasonable terms. The Federal land bank will be enabled to act as an ever-ready means of serving the farmer at all times, because of the nature of the plan under which it places the farmer's security on the market.

As already stated, the land bank will not undertake to sell the farmer's mortgage note direct to the investor, as is the usual method under the present system. On the basis of these mortgages and other guaranties provided for in the law, the Federal land bank issues bonds of various denominations. This function of converting the farmer's mortgages into land-bank bonds is the primary business of the Federal land bank.

Not only does the Federal land bank convert the farmer's securities into bonds, but its capital and surplus (minimum $750,000) serves as added security for the protection of these bonds.

A third important service is rendered by the land bank in selling the land-bank bonds. The Federal land bank, because of its size and its prestige, through governmental connections, will have special opportunities to reach the open investment market for the sale of these bonds.

All of the above-mentioned services, including the conversion of the farmer's mortgages into bonds, the protection of the bonds by the land bank's capital and surplus, and the sale of the bonds, are provided in order that investment capital may be readily obtained for the farmer at all times on as favorable terms as practicable.

THE RELATION OF THE FEDERAL GOVERNMENT TO THE SYSTEM.

There are various ways in which the Federal Government renders assistance, in order to insure the prompt establishment of the Federal land banks on a sound basis and the proper management of these banks. The main responsibility for the inauguration and supervision of the Federal land-bank system is vested in the Federal Farm Loan Board of the Treasury Department. The first important work of the board, under the law, is the designation of the 12 land-bank districts and the selection of the land-bank city of each district. The board also has the task of organizing each of the Federal land banks. This includes making provision for the necessary capital stock. To insure that the minimum capital stock ($750,000) for each land bank will be subscribed for without delay, the law provides that, if any part of such stock remains unsubscribed for after 30 days from the time the books are opened for public subscription, it shall be the duty of the Secretary of the Treasury to subscribe for the unsubscribed balance. If necessary, the Federal Treasury is to subscribe for the entire minimum capital stock required for each Federal land bank.

The Federal Farm Loan Board appoints a temporary board of directors for each Federal land bank. After a Federal land bank has received subscriptions for its stock from local associations to the extent of $100,000 a permanent board of directors of nine members is elected for each land bank. Six of the nine directors are chosen by the local associations and three directors appointed by the Federal board. The board also appoints other officials connected with the system, as hereinafter mentioned.

The Federal Government pays the salaries of the members of the Federal Farm Loan Board, of a registrar for each land-bank district, and of the bank examiners.

There is one special provision in the law under which the board may call upon the Treasury Department to make deposits of Government funds for the temporary use of the Federal land banks. The Secretary of the Treasury is authorized to use his discretion in making such deposits and must be satisfied with the security given by the Federal land bank. The law provides that these deposits must not exceed $6,000,000 in the aggregate at any one time, and that the interest rate thereon must not exceed the interest charged for other Government deposits.

EXEMPTION FROM TAXATION.

The capital, surplus, and income of the Federal land banks and the local loan associations, together with all mortgages accepted and bonds issued under the act and incomes derived therefrom, are exempt from Federal, State, municipal, and local taxation.

THE WORK OF THE FEDERAL FARM LOAN BOARD.

The Federal Farm Loan Board, consisting of the Secretary of the Treasury and four additional appointees of the President,[1] as already stated, has general charge of the administration of the Federal Farm Loan Act. The board not only performs the temporary work of getting the Federal land-bank system established; it constitutes a permanent body of Government officials, charged with the general supervision of the land banks and loan associations created under the law. The board appoints the farm-loan registrars, land-bank appraisers, and land-bank examiners; it receives reports from the land banks and the local farm-loan associations; it approves the legal forms and blanks used by the land banks; and its approval is also required for each issue of bonds made by any land bank under the act.

THE DEPARTMENT OF AGRICULTURE COOPERATES.

While the Federal Farm Loan Board of the Treasury Department has charge of the administration of the law and will conduct investigations and diffuse information with reference thereto, the Department of Agriculture, through the Office of Markets and Rural Organization, which has conducted extensive investigations in matters pertaining to farm credits, will cooperate with the Federal board in supplying information and rendering assistance to farmers who desire to take advantage of the Federal Farm Loan Act, especially with reference to the organization of local loan associations. Section 3 of the law specifically provides for the use of the Department of Agriculture as a distributing agency for information regarding the Federal Farm Loan Act. Various agencies of the department, including the extension workers in the several States, will be utilized in this work.

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[1] See footnote, p. 1.

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FOXTAIL MILLET

ITS CULTURE AND UTILIZATION IN THE UNITED STATES

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FARMERS' BULLETIN 793

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. March, 1917

UTILIZED in the United States most largely as a catch crop. Adapted to a wide range of soils and climates.

Valued in semiarid regions because its short growing season often enables it to escape periods of drought.

Useful in ridding a field of weeds.

German and Hungarian are the best varieties for humid regions; Kursk and Common for the dry northwestern plains.

Seeding, harvesting, and thrashing millet are easy and simple operations.

The hay of foxtail millet has about the same feeding value as timothy hay.

Injury has resulted when millet hay was used as a continuous ration for horses.

Seed of millet should be ground before feeding.

Not valuable as a constituent of crop rotations.

Remarkably free from plant diseases.

Chinch bugs and army worms are the chief insect enemies.

FOXTAIL MILLET: ITS CULTURE AND UTILIZATION IN THE UNITED STATES.

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INTRODUCTION.

The name millet is applied to a number of cultivated annual grasses, some of which are used largely as forage crops and others as cereals; most of them, however, are used either for forage or for grain, according to the needs of the growers. In the United States all except the broom-corn millet are used almost exclusively for forage purposes, but in Africa, India, China, Chosen (Korea), Japan, and Russia the millets are grown extensively for human food. In China the broom-corn and foxtail millets are most common, and the grain, after being cleaned and hulled, is crushed and cooked as a porridge, much as certain breakfast foods are used in America. In India, pearl millet, which is grown there under the native name of bajra, is the most important millet. Chosen and Japan produce considerable proso and foxtail millet, and the latter country also devotes a considerable acreage to barnyard millet, which is grown there almost entirely for its seed; but the millet crop is of minor importance in these countries, as it is in Europe, where it is not cultivated extensively except in the Mediterranean region and in Russia. Much proso or broom-corn millet is produced in Russia, especially in the southeastern provinces.

No extended classification of the millets will be given in this bulletin. The main groups, as shown in Table I, are foxtail millet, proso (or broom-corn millet), penicillaria (or pearl millet), barnyard (or Japanese) millet, and ragi (or finger millet). Other forms little known and of small importance in the United States are Texas millet, or Colorado grass, which is found growing wild in Texas and northern Mexico and is cultivated to a slight extent in Oklahoma, Texas, New Mexico and Colorado; also Shama millet, Kutki millet, Koda millet, and little millet, all of which are grown to some extent as "famine crops" in India, but are not valued in the United States, where better crop plants are available.

TABLE I.—*Groups of millets, showing common and botanical names.*

[Where there are synonyms, the preferred name is given first, both in the common and botanical names.]

Common names.	Botanical names.
Foxtail millet Italian millet	*Chaetochloa italica* (L.) Scribner. *Setaria italica* Beauv.
Proso Broom-corn millet Hog millet Russian millet	*Panicum miliaceum* L.
Barnyard millet Japanese millet Sanwa millet Billion-dollar grass	*Echinochloa frumentacea* (Roxb.) Link. *Panicum frumentaceum* Roxb.
Pearl millet Penicillaria Cat-tail millet Egyptian millet	*Pennisetum glaucum* (L.) R. Br. *Pennisetum typhoideum* Rich.
Ragi Finger millet Coracan	*Eleusine coracana* (L.) Gaertn.
Shama millet Jungle rice	*Echinochloa colona* (L.) Link.
Texas millet Colorado grass	*Panicum texanum* Buckl.
Kutki millet	*Panicum psilopodium* Trin.
Koda millet	*Paspalum scorbiculatum* L.
Little millet	*Panicum miliare* Lamarck.

In India, Chosen, and certain parts of China the sorghums are referred to as "giant millet" or "tall millet," but this practice happily has not spread to the United States. Of all these millets the foxtail group is most important in the United States, especially for forage, and in the following pages, unless otherwise specified, any reference to millet will mean foxtail millet.

DESCRIPTION OF THE FOXTAIL MILLETS.

The foxtail millets are so well known that they hardly need description. They are annual grasses, with slender, erect, or ascending stems, mostly simple, but sometimes branching, from 2½ to 5 feet high under cultivation, and bearing broad, flat leaves. The seeds are borne in a rather dense, cylindrical spike, which, with the persistent bristles attached to the rachis at the base of each spikelet, provides a character by which the foxtail millets differ from all others. In the cultivated foxtail millets there are from one to three bristles to each spikelet. This number is the same in the weed known as green foxtail, supposed by most botanists to be the wild original of the cultivated plant. To the ordinary observer these millets appear more nearly like the yellow foxtail, or "pigeon grass," which is so abundant in stubble fields after the small grains have been harvested. The seeds are inclosed in thin, papery hulls, which are largely removed in thrashing, leaving free the small convex seed, which is oval or elliptical in outline. The grain or kernel of this seed is inclosed in a box formed by the persistent glumes, or "hulls." Such a fruit is called a caryocist.

The color of the seeds differs with the variety. In some varieties a portion of the seeds are black or dark purple, and in others all are a dull orange, but most of the foxtail millets have pale yellow or straw-colored seeds.

HISTORY OF MILLET.

Millet is one of the oldest of cultivated crops. Its planting has been mentioned in Chinese records as being part of a religious ceremony carried out by the Chinese Emperor as early as 2700 B. C. Probably native in southern Asia, its culture spread from there westward to Europe at an early date. In 1849 a distribution of millet seed was made by the United States Patent Office,[1] and in 1889 millet had become a rather important crop in the Central States, where it was found better adapted than along the Atlantic coast. By 1899 over 74 per cent of the total acreage of millet was found in the North-Central States. Kansas, with 349,906 acres, led all the States, and produced an average of 1.9 tons of millet hay per acre, against an average of 1.6 tons per acre for the whole United States. According to the Thirteenth Census (1909), Kansas was still first in millet production, the leading States ranking in the following order: Kansas, Missouri, Texas, Nebraska, North Dakota, Tennessee, and Oklahoma. The total production of millet for the United States, which in 1899 amounted to 1,743,887 acres and 2,850,959 tons of hay, decreased in the next 10 years to 1,117,769 acres and 1,546,533 tons of hay. It is quite probable that 90 per cent or more of this acreage is made up of the foxtail millets.

CLIMATIC ADAPTATIONS OF MILLET.

To succeed well, millet must have warm weather during the growing season. It does not grow well at high altitudes or in other localities where cool weather prevails during the summer months. Notwithstanding this preference for warm weather, millet is grown successfully in our most northern States, especially those in the Great Plains region, because in those States the summers, though short, are hot. Millet, as it matures quickly, can be planted and harvested during these summer months. The long days prevailing in this latitude provide plenty of sunshine, and thus a less period of time is required for maturing the crop. The longer seasoned varieties, like German and Turkestan, can be grown successfully only in the Central or Southern States.

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[1] Ann. Rpt. U. S. Comm. Patents, 1849, pt. 2, p. 464-465. 1850.

Millet does best in localities which have a fairly abundant rainfall. Many writers have referred to the millets as drought-resistant crops, and they do have a low water requirement,[1] but they lack the ability to recover after being injured by a period of drought. This ability to recover from drought injury is very pronounced in the sorghums, but the millets succeed in localities subject to drought almost entirely through their ability to escape periods of acute drought on account of their short growing season. Millet is usually one of the first crops to show the effect of a drought, mainly because of its shallow root system.

SOIL ADAPTATIONS OF MILLET.

A rich, loose, loamy soil is best for millet. Plenty of humus is advantageous, and for this reason millet is often planted on newly turned grass sod. It is a good crop for such situations also, because it seems to aid in disintegrating the sod. Good drainage is essential.

PLACE OF MILLET IN THE CROPPING SYSTEM.

Millet is grown chiefly as a catch crop and is not important as a constituent in a regular cropping system. Most farmers use it to overcome an expected shortage in their hay supply or to occupy a field which would otherwise be idle on account of the failure of a regular crop or because climatic conditions have prevented the seeding of such a crop. Millet is admirably suited to such use because of its short season of growth and the ease and certainty of obtaining a stand. The plant is also adapted to a wide range both of soils and of climates. Large yields are not obtained either on poor soils or in dry climates, but millet has been found to make a heavier yield under such conditions than most other hay crops. The strongest competitor of millet which has yet been found is Sudan grass, which promises to replace millet in many localities as a catch crop, so that a further decrease in the acreage of millet is to be expected. The quality of Sudan grass hay is superior to that of millet, and its yields under comparable conditions are nearly always larger (Table II), but the growing season is a trifle longer than that required by either Common or Hungarian millet.

Foxtail millet is used to some extent as a soiling crop, but it is not as well suited for this purpose as the sorghums and some of the small grains. Pearl millet is better for use as a green feed than the foxtail millets, because of its larger yield and its ability to make a second growth after being cut down; and both pearl millet and barnyard millet are better silage crops than foxtail millet, because of their larger yields and greater succulence.

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[1] Briggs, L. J., and Shantz, H. L. The water requirement of plants. U. S. Dept. Agr., Bur. Plant Indus. Bul. 284, p. 28. 1913.

——— Relative water requirement of plants. *In* Jour. Agr. Research, v. 3, no. 1, p. 27. 1914.

Some farmers have made use of millet as a means of ridding a field of weeds. It is very effective for this purpose, on account of the completeness with which its roots occupy the surface soil, the good stands usually obtained, and the vigor of the early growth.

VARIETIES OF MILLET.

The foxtail group of millets includes ten or more varieties, which are quite distinct in habit of growth and adaptation to different climatic conditions, although all are very closely related botanically.

COMMON MILLET.

Common millet has been variously known to the seed trade under the names[1] Early Harvest, Missouri (in part), Dakota (in part), and Italian millet. The date when it was introduced in the United States is not definitely known, but it was one of the first to be grown in this country. It is planted rather extensively over the entire area where millets are grown and makes up a large percentage of the acreage of millets in the Dakotas, Iowa, Nebraska, Kansas, and Oklahoma. In the Southern States German millet is more widely grown than the Common millet. This is very largely due to a longer growing season in these States and the correspondingly larger yield of German millet.

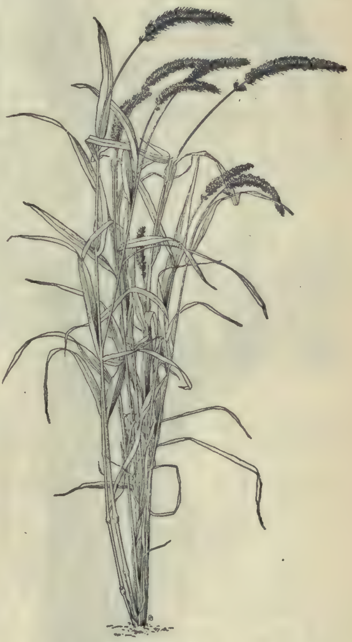

FIG. 1.—A single plant of Common millet, showing the characters of the head and the tillers.

Common millet is fine stemmed and leafy, with a close, compact head, tapering slightly toward the upper end, the lower part of the head usually being looser than the middle and upper part. (Fig. 1.) The individual seed is yellow to straw color, oval to elliptical in outline, and decidedly flattened on one side. Common millet is characterized by a short season of growth, being one of the earliest of the foxtail millets. Tests in the Central States show that under average conditions it can be cut 69 days after the date when sown, and in many cases only 50 days are required for it to mature sufficiently for hay. Under favorable conditions it produces 1 to 2 tons of hay to the acre, and this hay is of first-class quality on account of the slender stems and abundant leaves.

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[1] Williams, T. A. Millets. U. S. Dept. Agr., Farmers' Bul. 101, p. 10. 1899.

In European countries, especially in France, the Common millet is known quite widely in the seed trade as Green California. Common millet resembles the wild foxtail more closely than any other variety does, and this is good reason for the belief that it was the earliest cultivated type of foxtail millet.

GOLD MINE AND CALIFORNIA MILLETS.

These are heavy-yielding varieties, closely related to Common millet. Neither of these varieties is very well known, but the Gold Mine especially deserves a wider utilization and should be planted by farmers in preference to Common millet in sections where seed of it is available.

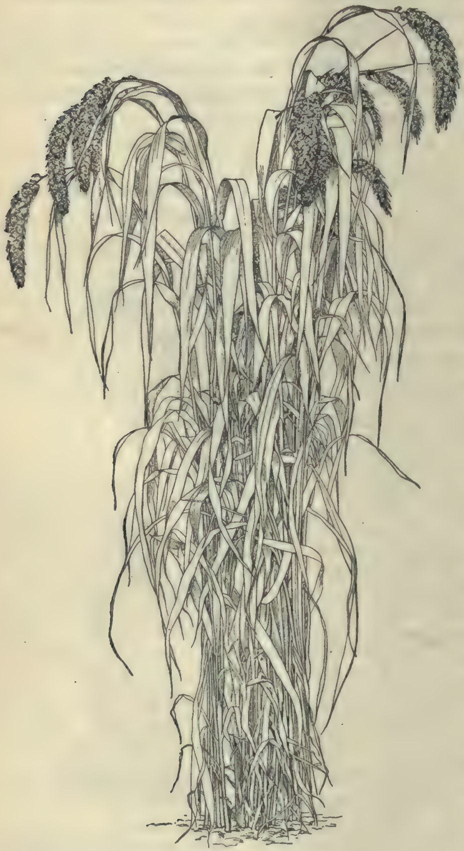

FIG. 2.—German millet grown from southern seed at Chillicothe, Tex., in 1909.

GERMAN MILLET.

This variety is often sold as "Golden millet," which is about the only trade name, other than German millet, which is used for it at the present time.

Several writers have confused this variety with the Hungarian millet, which came to the United States under the technical name of *Panicum germanicum* and was locally grown for several years as "German millet." German millet, on the other hand, was known in early days as "Bengal grass," but just how this name originated can not be determined. This variety became important first in the central valley of Tennessee, and this locality has continued to be the center of its distribution, many farmers in the vicinity of Franklin, Tenn., making a specialty of the production of German millet seed. In the Southern States it has almost entirely supplanted other foxtail millets and besides is perhaps the principal millet in the Central States, since it is handled by more seedsmen than any other variety. In many places where it is grown, the season is not long enough to mature a seed crop, but it becomes sufficiently mature for hay and makes larger yields than the earlier kinds.

German millet has heavy stems, with broad leaves and a distinctly lobed head, nearly twice the diameter of that of Common millet, but only slightly longer and not so compact. (Fig. 2.) The individual seeds are smaller and more nearly round in outline than those of Common millet. The surface of the seed coat of German millet is quite rough, with numerous minute elevations, which give it a dull appearance, while Common millet seed has only indistinct transverse ridges, which give it a polished or somewhat shiny appearance. (Fig. 3.) Another difference between the seed of these two varieties lies in the length of the internode between the first and second empty glumes. In German millet this internode is noticeably longer than in Common millet. These differences, which can be plainly discerned with the aid of a small hand lens, provide a ready method of distinguishing German millet from Common millet by an examination of the seed alone, but these characteristics are not sufficient to set these varieties apart from all other varieties of foxtail millet; for example, Golden Wonder millet has seeds which have the same characteristics as those of German millet, and the yellow seeds in Hungarian millet are similar to those of Common millet. Besides these two well-

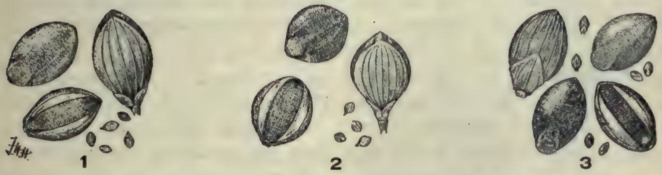

FIG. 3.—Seeds of Common (1), German (2), and Hungarian (3) millet, showing differences in size, shape, and surface characters. These drawings and the explanation of this figure in the text were furnished by F. H. Hillman, assistant botanist, Seed Laboratory, United States Department of Agriculture.

known millets, imported varieties obtained in China and Manchuria have seed to all appearances identical with that of German millet, but are different in their habit of growth and not so valuable from a forage standpoint. The chief need in the past, however, has been a method of distinguishing between seed of Common and that of German millet, which varieties are often found mixed in commercial seed. The method described is offered as a solution of this problem alone.

A belief is prevalent in the Northern and Central States that after German millet has been grown in these localities for several years it deteriorates or takes on the habit of growth and other characteristics of Common millet. True German millet does not always mature perfectly in the latitude of Iowa and Nebraska, and seed obtained from plantings of the German millet in these States is apt to consist rather largely of the earlier and smaller forms, which resemble Common millet. It is this fact, no doubt, which has given rise to the belief that German millet will not maintain its characteristics when grown continuously for several seasons in the latitude of central Illinois, Iowa, and Nebraska. A comparison of northern-grown with southern-grown seed at Arlington Farm, Va., showed very little difference between the two crops so far as vigor of growth or yield of hay was concerned, but the southern seed produced a more uniform and distinctively German type of plants and had a much smaller admixture of Common millet in it than the crop from northern seed.

German millet is a long-season variety, requiring on the average about 87 days, although under favorable conditions 65 days are sufficient for a hay crop. The hay yield is larger than that of Common millet, but the quality of the hay is not so good.

GOLDEN WONDER MILLET.

This variety has a heavy stem and broad leaves very much like those of the German millet, but the head, although distinctly lobed, is more compact, longer, and more slender than that of the latter variety, and the bristles are so short as to be scarcely noticeable. (Fig. 4.) It makes good yields of both forage and seed and for a time was widely advertised as a new millet of very desirable qualities, but it was found to be more easily injured by dry weather than other well-known varieties, and the difficulty of obtaining reliable seed of it has prevented its wide utilization.

HUNGARIAN MILLET.

This variety probably originated in Europe, but it was grown in the United States as early as 1830. It did not become popular, however, until after its distribution by the Patent Office in 1854 under the name of Moha de Hongrie or *Panicum germanicum*. It seemed especially well adapted to the rich soils of the Mississippi Valley States and in Iowa came to be known as "Hungarian grass." In other States it was grown under the name of "German millet," probably because of the botanical name which was attached to it by the Patent Office at the time of its introduction and the belief that it came from Germany. This name for Hungarian millet gradually fell into disuse as the other variety, which we now know as German millet, came to be better known.

Many seed dealers and farmers still call the variety "Hungarian grass," and this name is even now used in publications. The use of such a title for this millet is unwarranted and should be discontinued, as it gives rise to confusion with Hungarian brome-grass, an entirely distinct grass which is not at all related to Hungarian millet. By referring to this variety properly as Hungarian millet no confusion can exist.

Hungarian millet is characterized by a small, compact head, which in size and shape resembles that of Common millet very closely. The bristles, however, are usually purple in color, which, with the intermixture of dark-colored seeds, gives the head a darker appearance than that of Common millet. (Fig. 5.) The individual seeds have the same oval or elliptical outline as those of the Common millet, but the color varies from pale yellow to brown, and sometimes very dark purple. Seeds of both colors are found in one head, but the colors are not mixed in a single seed. The season of maturity is about the same as that of Common millet, averaging 69 days in the Central States, but this variety will mature for hay in 54 days when soil and climatic conditions are right. Hungarian millet is not so well adapted to dry climates as the Common millet, and the yield in such localities is apt to be small, but in the Eastern

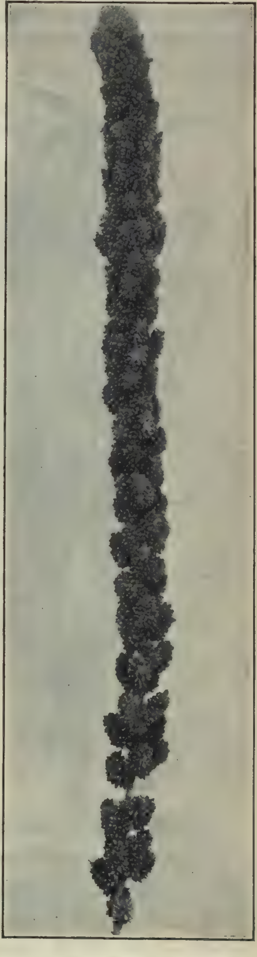
FIG. 4.—A head of Golden Wonder millet: Length, 10 inches; diameter, three-fourths of an inch.

States, where the rainfall is greater, Hungarian millet does well and is widely grown.

The quality of the hay is first class, and chemical analyses seem to indicate a slightly higher protein value for it than for the hays of other millets. The main objection to Hungarian millet in the humid regions has been its tendency to volunteer and persist on the land whenever it was allowed to produce seed.

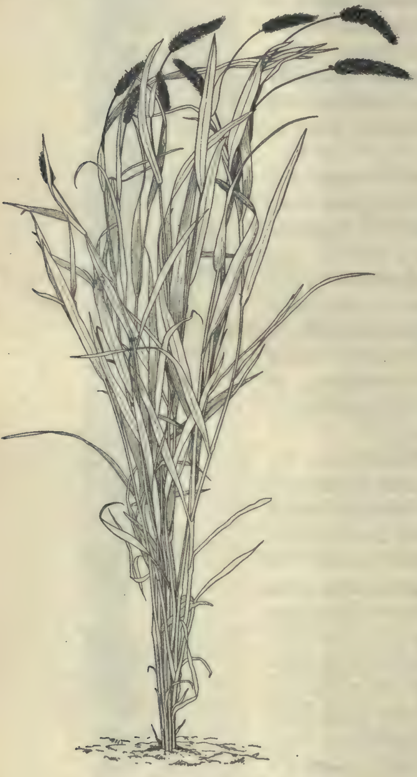

FIG. 5.—A single plant of Hungarian millet.

SIBERIAN MILLET.

This variety was obtained from Russia about 1895 and was handled by the seed trade under this name for a number of years before the other two orange-seeded varieties, Kursk and Turkestan, were introduced by the United States Department of Agriculture. Siberian millet is hardy and drought resistant and is suited to Minnesota, the Dakotas, Montana, Wyoming, Colorado, western Nebraska, and western Kansas. In habit of growth and vegetative characters generally it is quite similar to Common millet, but it is a trifle more vigorous, and the head is somewhat larger. (Fig. 6.)

The seeds, although similar in shape to those of Common millet in some cases and in others round like those of German millet, are always orange in color, and this character provides an easy method of identifying the variety when seed is purchased. The season of growth is slightly longer than that of Common millet and the yield is somewhat larger, the hay being about the same as that of Common millet in quality and feeding value.

KURSK MILLET.

This variety is really a selection from the Siberian millet. It was obtained by the United States Department of Agriculture in 1899, from the Province of Kursk, Russia; whence its name.

Kursk millet has become popular in the western parts of North Dakota and South Dakota and in eastern Montana and Wyoming, where no other variety can be so well depended upon to produce a hay crop in seasons of drought. Farther south and east, where the rainfall is greater and the growing season somewhat longer, the Gold Mine, German, and Turkestan millets will outyield the Kursk considerably.

Kursk millet differs from the parent strain, Siberian millet, in being somewhat less vigorous in growth and having a smaller, more compact head. The head resembles that of Hungarian millet very closely in size and shape and also in having purple-tipped or entirely purple bristles. Kursk millet is much more uniform than the commercial Siberian millet, because it has been the subject of selection during nearly the entire period since its introduction into the United States. This variety is the earliest of all foxtail millets, requiring an average of only 64 days to produce a hay crop, and in many cases it has been ready to cut for hay in 45 days from the date of seeding. It produces large yields of seed, often exceeding those of the proso, or broom-corn millet, which is considered distinctively a grain millet.

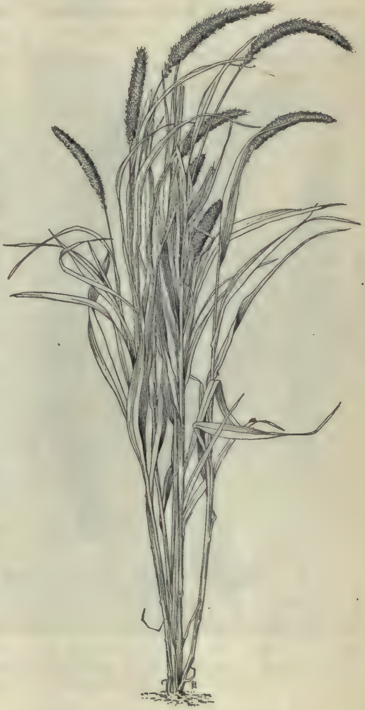
FIG. 6.—A single plant of Siberian millet.

TURKESTAN MILLET.

This is a large, coarse-stemmed variety with orange seeds, related to the Siberian millet. It was brought to the United States in 1907 from Russian Turkestan and is not very widely known. It requires a long growing season, averaging 93 days, and produces a large yield of hay of a rather poor quality. Turkestan millet is adapted only to the Southern States, and especially to Texas.

AINO OR JAPANESE MILLET.

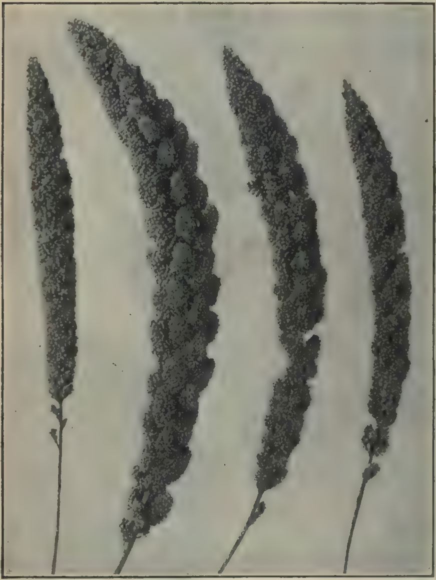

FIG. 7.—Characteristic heads of the Aino or "Japanese foxtail" millet, showing lack of uniformity.

The use of the name "Japanese millet" for varieties of foxtail millet and proso, as well as for the barnyard millet, has been the cause of considerable confusion. In the United States the term "Japanese" is now restricted very generally to the barnyard millet, but the Massachusetts experiment station, about 1889,[1] introduced several varieties of foxtail millet from Japan and also some proso varieties, all of which they tested and distributed under the name "Japanese millet." The proso was distinguished in some cases by calling it "Japanese panicle millet," and a few writers called the foxtail millet "Japanese Common," or "Japanese foxtail millet;" but this was rarely done, and the seed dealers and farmers have been for years at a loss to know just what to expect under the name Japanese millet. Because of this uncertainty it seems desirable to cease using the term "Japanese" in connection with the foxtail millets which have originated in Japan. Carleton[2] has suggested the name Aino for the Japanese foxtail millet. The Ainos are a prehistoric race of Japan who are supposed to have grown this millet. Among the specimens of Aino millet which were furnished to the United States Department of Agriculture there are some individuals resembling Common millet very closely, while others are more like the Golden Wonder, this variety seeming much less uniform than the others just described. (Fig. 7.) It has been of less value in the United States than other well-known millets and is not likely to gain recognition as a standard variety.

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[1] Brooks, W. P., and others. Fertilizers. Mass. (Hatch.) Agr. Exp. Sta. Bul. 18, p. 93, 98. 1892.

[2] Carleton, M. A. Millets. *In* Bailey, L. H., Cyclopedia of American Agriculture, v. 2, p. 472–473. 1907.

COMPARISON OF VARIETIES.

The chief differences in the plant characters of the principal varieties of foxtail millet and their average yields, as indicated by experiment station results for different sections of the United States, are given in Table II in comparison with those of proso and Sudan grass. (Fig. 8.)

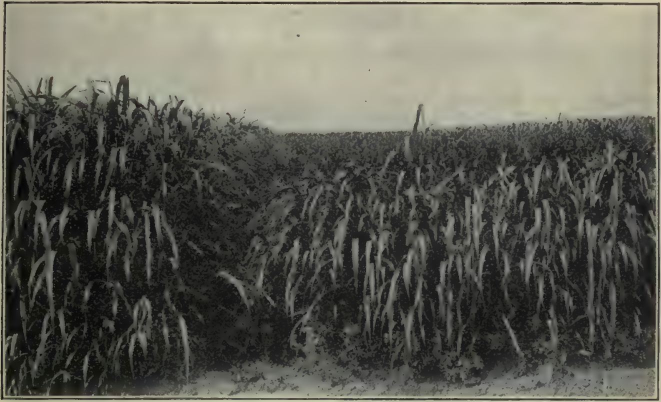

FIG. 8.—Kursk millet (on the right) and Sudan grass (on the left) at Redfield, S. Dak., August 10, 1915, 68 days from date of seeding.

Most seed firms now carry in stock only the well-known varieties and list them under their proper varietal names, a practice which can not be too highly commended. The frequency with which the different varieties were listed in the 1916 catalogues of 22 seed firms, selected as representative of all sections of the United States, is as follows:

German	21 firms.	Common	7 firms.
Hungarian	16 firms.	Kursk	3 firms.
Siberian	10 firms.	Dakota	1 firm.

The above list includes all of the foxtail millets advertised by these 22 seed firms, and it will be noted that the Dakota, which is listed by only one firm, is the only variety not generally recognized. In many cases the German millet was listed as "German or Golden," and in several instances Hungarian millet was listed as "Hungarian grass."

There are many other distinct types of foxtail millet besides the varieties which have been described, but no others have exhibited sufficient promise to warrant their discussion in this bulletin. It is quite possible that better varieties of millet may be developed than the German, Common, Hungarian, or Kursk, but these varieties seem to supply the needs of the farmers at the present time.

Table II.—Plant characters of the principal varieties of foxtail millet and yields of these millets, proso, and Sudan grass for different sections of the United States.

CONTRASTING PLANT CHARACTERS OF THE PRINCIPAL VARIETIES OF FOXTAIL MILLET.

Variety.	Average period of growth.	Size of stem.	Size of head.[a]	Character of head.	Length of bristles.[b]	Color of bristles.	Outline of seed.	Color of seed.
	Days.							
Common	69	Slender.	Medium.	Not lobed.	Long.	Pale yellow.	Oval to elliptical.	Pale yellow.
German	87	Stout	Large	Distinctly lobed.	do.	Green to purple.	Round	Do.
Golden Wonder		do.	do.	do.	Short.	Pale yellow.	do.	Do.
Gold Mine	69	Medium.	Medium.	Not lobed.	Long.	do.	Oval to elliptical.	Do.
Hungarian	69	Slender.	Small	do.	do.	Purple	do.	(c)
Siberian	72	Medium.	Medium.	do.		do.	do.	Pale orange.
Kursk	64	Slender.	Small	do.	Long.	do.	do.	Do.
Turkestan	93	Stout	Large	Slightly lobed.	do.	do.	do.	Do.

YIELDS OF FOXTAIL MILLETS COMPARED WITH THOSE OF PROSO AND SUDAN GRASS.

Locality.	Length of test.	Hay per acre (tons).							
		Foxtail millets.						Proso.	Sudan grass.
		Common.	German.	Kursk.	Gold Mine.	Hungarian.	Turkestan.		
	Years.								
Great Plains:									
Northern	5	1.66	1.56	1.79	1.36	1.62	1.73	1.38	2.19
Central	4	1.71	2.76	2.04	2.30	1.88	2.00	1.27	3.20
Southern	5		2.12	1.27	1.62	1.37	2.44		3.74
Northern Mississippi Valley	7	1.80	2.15	2.16		2.05		2.04	3.38
Northeastern corn belt	7	2.55	[d]3.72			2.80		2.62	3.20
Southeastern States	4		3.25			2.42			3.45

[a] In this class the term "small" indicates heads 3 to 4½ inches long and one-half to five-eighths inch in diameter; "medium" indicates heads 4½ to 6 inches long and five-eighths to three-fourths inch in diameter; "large" indicates heads 6 to 9 inches long and 1 to 1¼ inches in diameter.

[b] Under this class the term "long" indicates bristles longer than the spikelets, making the heads appear bristly; "short" indicates bristles shorter or about equal in length to the spikelets, so that the head appears smooth.

[c] Some pale yellow, some purple or black.

[d] The high yield of German millet is largely due to the Ohio figures, which give German millet an average yield of 5.1 tons of hay per acre for a period of six years.

PREPARATION OF THE SEED BED.

The millets are usually sown on spring plowing because of their use as a catch crop, and also on account of their being seeded late in the spring. Spring-plowed is preferable to fall-plowed land, because the operation of plowing usually destroys one crop of weeds. If the plowing is done about two weeks before the time for seeding, another crop of weed seeds will germinate, and this second crop can be killed by cultivating the ground thoroughly with a spike-tooth harrow or a disk. If a disk is used it should not be set at too great an angle, and it is usually best to lap half way, so that the ground will not be ridged. When fall plowing is used for the seed bed it should always be disked before sowing the millet. A rather fine and firm seed bed is necessary on account of the small size of the seeds, and the ground should be thoroughly leveled and all of the clods crushed, so that there will be no unevenness in the surface to interfere with the mowing machine. Clods are also disadvantageous because they are apt to be gathered up by the rake and remain in the hay, adding considerable useless weight as well as making the hay dusty and dirty.

DATE OF SEEDING.

The time of seeding millets permits considerable latitude because of their short season of growth. Millet should not be sown, however, until the ground is warm. This means ordinarily about two or three weeks after corn-planting time. In the Central States the preferable time for seeding lies between the last of May and the middle of June. Millet may be sown three weeks earlier than this, however, in case of an early spring. From this date it can be sown with reasonable hope of success at any time up to August 1, and in the Southern States even later. The last seeding should allow for 60 to 70 days of growing season before the normal date of the first killing frost, as indicated on the Weather Bureau chart (fig. 9). By consulting this chart the limits of seeding dates for millet can be readily determined, within reasonable limits, for any part of the United States.

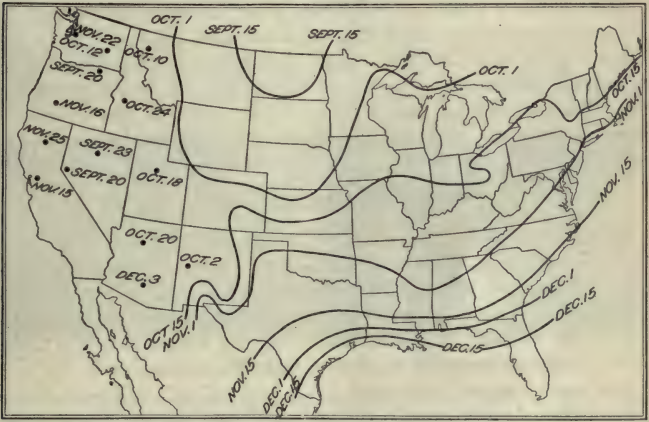

FIG. 9.—Outline map of the United States, showing the average date of the first killing frost in autumn, as indicated by Plate XIX, Weather Bureau Bulletin Q (1906).

If weather conditions are favorable, a cutting of millet can often be obtained 45 days from the date of seeding Unfavorable conditions, however, including either a period of drought or unseasonably cool weather, result in an average period of about 70 days for Common, Kursk, and Hungarian millet and 85 days for German millet.

Where the season is long it is often possible to obtain a crop of millet after harvesting small grain, such as oats, barley, or fall wheat. In such cases the ground may be prepared for seeding by disking the stubble. Double cropping of this nature, where both crops are nonlegumes, is not a good practice, since the following crop is usually very much reduced. It should be resorted to, therefore, only in cases of evident need of hay.

RATE OF SEEDING.

In the more humid areas it is a good practice to seed 25 to 30 pounds (about 2 pecks) of millet per acre. In semiarid districts the rate can be reduced to 10 or 15 pounds per acre, especially if the seed bed is in good condition and a grain drill is used so that the seed will be applied uniformly over the entire surface. It is always well to use sufficient seed, so that weeds will not have an opportunity to obtain a foothold in the millet field. It is much better to have millet plants occupying the soil than to have spaces filled with weeds.

METHOD OF SEEDING.

Where the seed bed has been put in good condition and sufficient seed is used, it is easy to obtain a good stand of millet either by using a grain drill or by broadcasting the seed. Care should be taken not to cover the seed too deeply unless the soil is loose and rather dry on the surface. If the surface is slightly rough, as it will be left after using a spike-tooth harrow, a light harrowing, with the teeth of the harrow sloped backward at an angle of 45°, will be sufficient to cover broadcasted seed. Where there is no danger of the surface of the soil baking, a plank or other drag will cover the seed and often insure a better germination than the spike-tooth harrow, because such tools pack the soil around the seed.

It is advised wherever possible to use a grain drill in seeding millet. If difficulty is encountered in adjusting the feed so as to limit properly the quantity of seed planted, this can be remedied either by mixing wheat bran or some other inert matter with the seed or by stopping up alternate holes in the drill. If the seed is mixed with about twice its quantity of cracked wheat and the drill set to sow 3 to 4 pecks of wheat, it will distribute 20 to 25 pounds of the millet seed per acre.

Some writers have advised cultivating the millet with a spring-tooth harrow after it has come through the soil and reached a height of 3 or 4 inches. This is usually not necessary, however, unless the surface of the ground is baked and hard. Even then there is danger of destroying a considerable percentage of the young plants, and experimental tests have shown that such culture does not often result in increased yields of hay.

HARVESTING MILLET FOR HAY.

Millet can be cut for hay with a mower in the same manner as timothy or any other hay crop. It usually stands erect and does not often interfere with the perfect operation of the mower. That which is cut early in the morning, if there is abundant sunshine, can usually be raked into windrows late in the afternoon. It is well, however, to allow it to cure in the swath about one day, after which it can be raked into windrows and allowed to cure sufficiently to be placed in cocks like timothy. After standing a week or more in the cock it can then be stacked or baled. Millet hay sheds water well, and if the cocks are properly built light rains will not do much damage. Canvas covers for the cocks, however, will save a great deal of hay.

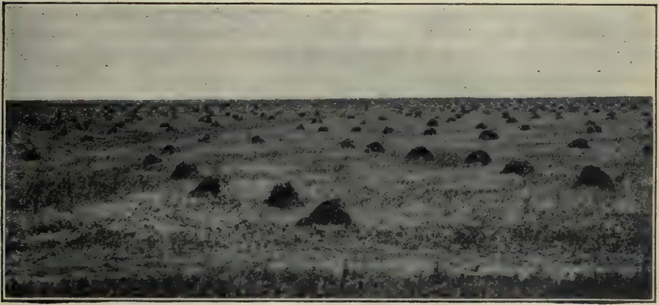

FIG. 10.—A 230-acre field of millet harvested for seed in western Kansas.

If the hay is designed for general use, that is, for feeding both cattle and horses, it should be cut just after blooming. The feeding value of the hay is perhaps greatest from this time until the seed reaches the milk stage.

HARVESTING MILLET FOR SEED.

Where a seed crop is the object, millet is best harvested with a grain binder and placed in shocks like bundle grain. It can be allowed to stand in the field until the grain in the head can be rubbed out in the hand. When it has reached this stage of maturity there will be little trouble about the millet spoiling in the bundle unless a period of wet weather is encountered. (Fig. 10.) In climates where cloudy, wet weather is apt to prevail during the harvesting season it is better to cut the millet with a mower and handle it as one would a hay crop. This method, however, wastes considerable of the seed, which shatters out when the crop is being placed in the cock and later when hauled to the stack. Cutting with a grain binder prevents a great deal of this loss and also leaves the millet in better shape to be thrashed, so that the task of thrashing can be accomplished more satisfactorily.

THRASHING MILLET.

Millet can be thrashed with an ordinary grain separator, the only change necessary being a substitution of screens capable of handling the small seed. Clover screens are often used for millet. Where the crop has been harvested with a binder the concaves do not need to be set very close to the cylinder, as the seed shells out very easily. Under such conditions the straw will not be broken up badly, and little trash or inert matter will be present in the seed The air blast should be regulated so that only the immature, nongerminable seeds will be blown out with the chaff.

FEEDING VALUE OF MILLET HAY.

Millet hay is usually considered inferior to that of timothy and some of the other tame grasses. This is due to some extent to its lesser palatability, but also to the injurious effect which it often has on horses when fed continuously as the sole roughage. The hay is slightly laxative and also acts as a diuretic, its effect on the kidneys being particularly noticeable in horses.

The hay can be fed without danger to cattle and sheep. As a feed for dairy cows it is valued by some, although others say it produces fat and decreases the milk flow. Chemical analyses show that millet compares favorably with timothy and Johnson grass in the actual amount of the different food elements which it contains. Table III presents the average of a number of analyses, compiled by Mr. G. L. Bidwell, of the Bureau of Chemistry, United States Department of Agriculture.

TABLE III.—*Food elements in the dry matter of millet, timothy, and Johnson grass.*

Crop.	Number of analyses.	Average constituents (per cent).				
		Ash.	Crude protein.	Fiber.	Nitrogen-free extract.	Ether extract.
Millet	40	8.82	9.85	30.08	48.22	3.03
Timothy	194	6.23	8.19	32.53	49.87	3.18
Johnson grass	40	7.71	8.80	32.72	47.77	3.00

The digestibility of these different elements is about the same in millet as in timothy, and somewhat lower in Johnson grass than in either of the others.

The Connecticut (Storrs) experiment station found Hungarian millet inferior to red-clover hay when it was fed to dairy cows. Both the quantity of milk and the percentage of butter fat increased by a change from millet to red-clover hay.

The general opinion among feeders is that millet hay is somewhat more effective than prairie hay as a roughage for growing stock, especially cattle and sheep. Very few, however, consider it equal to alfalfa or clover hay.

INJURIOUS EFFECT OF MILLET ON HORSES.

The injurious effect of a continuous ration of millet hay on horses was studied by Dr. T. D. Hinebauch,[1] of the North Dakota experiment station, in 1896. He found that when a horse was fed millet exclusively as a roughage for any considerable period a general debility was evident, and this later developed into a softening of the bones and inability to stand. Cessation of the use of the millet hay resulted almost immediately in improvement in the condition of the horse, while a resumption of the millet feeding was followed by a relapse. Dr. E. F. Ladd later found that the injury was caused by a glucosid called setarian, which is present in millet hay whether mature or not.

The belief is general that millet cut before seed has formed is much less injurious to horses, but the North Dakota experiments showed that cutting it before the seed has formed will not prevent injury. This injurious effect is noted (1) as producing an increased action of the kidneys; (2) in causing lameness and swelling of the joints; (3) in producing infusion of blood into the joints; and (4) in destroying the texture of the bone, rendering it softer and less tenacious, so that the ligaments are often torn loose from the bone and the bones themselves break easily. These results were verified by a post-mortem examination of two horses which had been fed millet as their sole roughage and can scarcely be subject to doubt, even though many newspaper articles deny that there is any danger in feeding millet hay to horses. When fed sparingly in connection with other kinds of hay, there is little danger of injury, and it can be used in this way with good effect to augment a roughage ration for horses.

GROWING MILLETS IN MIXTURES WITH LEGUMES.

Millets are sometimes used in mixtures with cowpeas or soy beans as a soiling or hay crop for dairy cows. This practice is more often followed in the Southern States than in those farther north. If one expects to utilize a mixture of this kind, care must be used in selecting the varieties of millet and cowpeas or soy beans, so that the two constituents of the mixture will arrive at maturity at about the same time. If Common millet is used, some very early variety of cowpeas or soy beans must be seeded in connection with it. With the German millet, varieties like the Whippoorwill, New Era, or Clay cowpeas or the Peking or Wilson soy beans succeed quite well in mixed seedings.

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[1] Hinebauch, T. D. Feeding of millet to horses. N. Dak. Agr. Exp. Sta. Bull. 26, p. 89-105. 1896.

Mixtures of millet and legumes produce a hay of better quality than the millet alone, so far as feeding value is concerned, since the legumes add the necessary protein element to the hay. The millet is beneficial to the legumes as a hay crop, because of its erect habit of growth and the ease with which it can be cured. Such mixtures are not always successful, because the millet is apt to start growth more promptly and crowd out the legumes either by shading them too much or by appropriating too large a percentage of the available soil moisture.

Another difficulty experienced is in obtaining a proper mixture. One way to accomplish this is to stop each alternate hole in the grain drill and seed the legumes first. Then seed the millet by running the drill in the same tracks, using only those holes which were previously stopped. It will provide for more nearly equal growth if there is a delay of four or five days between the times of seeding the legumes and the millet. Some provision for raising the hoes or disks of the drill which are not working must be made, so that the legume seed which has sprouted will not be disturbed. This method, of course, necessitates going over the field twice with the drill. Where the seed is mixed before it is placed in the drill, this double seeding is not necessary, but it is almost impossible to maintain a proper mixture of the seed as it leaves the feed in the drill. Most of the mixtures are broadcasted by hand and covered with a harrow. If labor is scarce and the time for seeding is short, this latter method is to be recommended. In the more humid districts 12 to 15 pounds of millet with 45 to 60 pounds of cowpea or soy-bean seed is advised. Where the rainfall is less abundant, in the semiarid district, 8 to 10 pounds of millet with 40 to 45 pounds of cowpea or soy-bean seed is better.

Owing to the difficulties of seeding and the fact that ofttimes a proper proportion of the legumes is not obtained, it is doubtful whether seeding in mixtures will ever become popular. Experiments have shown that better yields are obtained in most cases where the two crops are grown separately. They can be handled to better advantage in this way; and, after harvesting, the two crops can be fed alternately or mixed at feeding time, and thus the advantage, so far as the quality of the feed is concerned, will be as fully accomplished as if the millet had been grown in mixtures with the legumes.

MILLET AS A GRAIN CROP.

Foxtail millet has never been utilized to any great extent as a grain crop in the United States. In China and certain other parts of Asia, as was stated in the introduction, it is used more or less as human food. So long as wheat can be produced in the United States as abundantly and cheaply as at present little millet will be grown for human food. One method which seems most attractive at the present time is the utilization of the decorticated or hulled grain of the millets as a breakfast food. Preliminary tests have shown it to be quite palatable when properly prepared, and it should prove a strong competitor of the breakfast foods now on the market.

Proso, or broom-corn millet, is more distinctively a grain millet, and it has been used to some extent in North Dakota and South Dakota as a grain crop. Trials of the grain of broom-corn millet and the foxtail millets in rations for hogs and beef cattle indicate that it is much less valuable than corn for this purpose and does not equal barley as a flesh producer. The South Dakota Agricultural Experiment Station found that it took about 8 per cent more millet than barley to produce a pound of gain, and on this basis it would be about 16 per cent less efficient than corn as a hog feed. The meat produced by millet contained a greater percentage of lean than that produced by other feeds, and the fat was softer. For feeding steers it required 37 per cent more millet than corn to produce a pound of gain, 29 per cent more than oats, and 22 per cent more than spelt.

Yields of 15 to 30 bushels of grain are obtained under favorable conditions, and although broom-corn millet is considered a grain millet, Kursk millet has consistently outyielded it when comparative tests were carried on to determine grain yields. The seed of the Kursk millet, however, is smaller than that of broom-corn millet and less valuable when fed whole to stock, as it is more apt to pass through the animal undigested. When properly fed, however, the seed of foxtail millet gives results practically equal to those obtained with proso, so that the South Dakota results may be considered as an index to its value as grain. In feeding millet grain it is always well to crush or grind it before giving it to the animal. Mixing it with wheat bran or adding to the ration some concentrate like cottonseed meal or linseed cake, which are high in protein and fat, is recommended.

A large quantity of millet seed is used as chicken feed and in prepared bird foods. For such purposes both the foxtail millet and the proso seed can be used without grinding. An analysis[1] of one well-known bird-seed preparation showed it to contain—

	Ounces.
Canary seed	4.75
Hemp (largely hulls)	2.50
Rape seed	.50
Common millet seed	7.75
Cuttle bone	.50
Total	16.00

For canaries and other small birds the foxtail millet is used a great deal, and, as in the above sample, where it is the cheapest constituent, it often makes up about half the weight of the sample. For larger birds the proso seed is commonly used, and in some cases it is substituted for the canary seed, to which it bears a slight resemblance if light colored.

The legal weight per bushel for seed of the foxtail millets is 50 pounds in most States, and well-cleaned seed of most varieties will be found to weigh between 45 and 50 pounds to the bushel very consistently.

PASTURING MILLET.

Most of the millets are not suitable for pasture purposes, and this is especially true of the foxtail varieties. The main difficulty lies in the shallow root system, which allows the plants to be pulled up very easily. Another weakness of millet as a pasture plant is that it does not renew its growth very quickly after being cropped off. The Common and Hungarian varieties are best in this respect. It is not to be recommended, therefore, as a pasture plant except to supply a limited amount of pasture in an emergency for young stock, like calves or colts, and even for such animals some other annual hay plant might be used to much better advantage. Winter rye or spring oats will furnish more and better pasture than millet.

VALUE OF MILLET IN ROTATIONS.

The millets, being annual crops, can be used in almost any rotation where a spring-sown crop is required. Most farmers who have grown millet believe it to be rather exhaustive of soil fertility. It has been proved that no more plant food is removed from the soil by millet than by other crops where a like tonnage of hay is produced. It is likely that the effect on the following crop comes through the depletion of available plant food and moisture in the upper 6 or 8 inches of soil. Other crops with a deeper root system gather their plant food and moisture from greater depths, and thus the plant food required for the following crop is not so completely exhausted from that portion of the soil in which the new crop must begin its growth. Another reason why millet might have a bad effect on the following crop is the small quantity of vegetable matter left on the soil by a crop of millet which has been harvested for hay. The stubble which is left after mowing is exceedingly short, and all of the trash is raked up, so that little vegetable matter of any kind is left for the production of humus when the stubble is plowed under. Considering all of these points, it is quite likely that there is some foundation for the belief that a crop following millet will be less than one which follows a crop of small grain or corn, even though these other crops are not classed as soil builders. Millet, therefore, can not be recommended as a regular constituent in any rotation.

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[1] Crozier, A. A. Millet. Mich. Agr. Exp. Sta. Bul. 117, p. 20. 1894.

USE OF FERTILIZERS FOR MILLET.

It has been found by a number of tests that the use of fertilizers on ground which is to be seeded with millet is not advisable. Of the three principal elements of commercial fertilizers, nitrate of soda is more likely to show a profit than phosphate or potash. This, of course, will depend to some extent upon the nature of the soil itself. Rather complete fertilizer tests were carried on by the New Jersey Agricultural Experiment Station in 1888.[1] These tests included separate applications of nitrate of soda, superphosphate, and muriate of potash at the rate of 150 pounds, 350 pounds, and 150 pounds, respectively. These three fertilizer elements were also used in combinations of two and three. Land plaster was also tried, at the rate of 400 pounds per acre, and barnyard manure, at the rate of twenty 2-horse loads per acre. None of these applications showed a profit except the nitrate of soda, and the net gain in that case amounted to only 73 cents per acre.

The Tennessee Agricultural Experiment Station,[2] on the contrary, obtained a decided increase in hay yields with nitrate of soda and also with acid phosphate when applied to millet fields on silt loam and sandy-loam soils. Muriate of potash used in connection with nitrate of soda and acid phosphate gave an increase in yield on some soils, but not on others. In all cases it appeared less valuable than the two other elements. Where nitrate of soda was used in conjunction with acid phosphate, 160 pounds per acre of the former and 150 to 300 pounds of the latter fertilizer were used with profit. The acid phosphate and the muriate of potash were harrowed into the soil before seeding, while the nitrate of soda was applied as a top-dressing at the rate of 160 pounds per acre as soon as the millet came up.

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[1] Arnold, A. P. Field experiments. *In* Ann. Rpt. N. J. Agr. Exp. Sta. 1888, p. 83–89. 1889.

[2] Tenn. Agr. Exp. Sta., Report of cooperative and extension work, 1907–8, p. 22–24. 1908.

The Rhode Island Agricultural Experiment Station[1] states that "this [German] millet is usually injured by heavy applications of lime, even upon acid soil." In the experiment described, however, the application of a ton of slaked lime per acre just before the crop was planted resulted in an increase in yield in every case but one. Phosphate fertilizers gave an increased yield in every case, but the percentage of increase due to the phosphate was greater on the unlimed than on the limed plats.

These conflicting results indicate that the profitableness of using fertilizer for millet depends largely on the nature and needs of the soil, and those needs must be determined separately for each individual case. Ordinarily fertilizers should be applied to other crops in the rotation rather than to the millet.

DISEASES OF MILLET.

The foxtail millets are less subject to destructive plant diseases than most other crops. There is in some cases a slight tendency to smut, but this trouble does not affect the hay crop seriously, and in the semiarid regions the extent of the damage to the crop of grain is very slight. The common smut of the foxtail millets is technically known as *Ustilago crameri* Körn, and it can be controlled by treating the seed with hot water or formalin. If the hot-water treatment is employed, the smutted seed should first be floated off by throwing the seed loose into cold or lukewarm water. The seed should then be placed in a porous bag or woven basket and dipped in water at a temperature of 110° to 120° F. to warm the seed, after which it is immersed for 10 minutes in water at a temperature of 132° or 133° F. The temperature of the water should be retained during the 10 minutes at not less than 130° F. After treatment the seed is dried quickly, to prevent its sprouting.

The formalin treatment is much simpler and is gradually superseding the hot-water treatment for smuts. It consists in dipping the seed in a solution containing 1 pint of formalin to 30 gallons of water. The seed may be put in sacks or baskets containing one-half to 1 bushel each and immersed in a barrel of the formalin solution for about 10 minutes. When taken out, the sacks of wet seed are suspended, so that they will drain, or the seed is placed in piles and covered for two hours, after which it is dried as rapidly as possible to prevent it from sprouting. Shoveling the seed over frequently will accelerate the drying process.

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[1] Wheeler, H. J., and Adams, G. E. Continual tests of nine different phosphates. R. I. Agr. Exp. Sta. Bul. 118, p. 71-72. 1907.

INSECT ENEMIES OF MILLET.[1]

The most destructive insect enemies of millet are the chinch bug and army worm. These insects are very fond of the foxtail millets, and when abundant in any locality their injuries to the millet crop are frequently very great. Millet is therefore sometimes used as a trap crop for the protection of fields of corn or small grains, but this method is not often successful where chinch bugs occur in large numbers, and therefore is not recommended. A successful way of protecting fields of millet from chinch-bug invasion is by means of a deep furrow plowed around the edges of the field to be protected, running the land side of the plow toward the field. In dry weather the sides of the furrow thus made can be rendered so steep and the earth so evenly pulverized that the chinch bugs can not crawl out of it. In showery weather the bottom of the furrow can be smoothed with a shovel, thus making it easier for the bugs to follow along the bottom than to climb the sides of the ditch. If holes with perpendicular sides are then dug across the bottom of the ditch at intervals of 30 to 40 feet, the chinch bugs will fall into them and can be disposed of easily by the application of kerosene oil.

The army worm also may be prevented from reaching fields of millet by the use of precisely similar furrows in which the caterpillars may be crushed by dragging a chunk or log back and forth in the furrow.

When a large brood of grasshoppers hatches in a locality they are likely to do considerable damage before they arrive at maturity. The most effective way of destroying them is by scattering poisoned bran about the edge of the field. This grasshopper poison is made up of the following ingredients:

Bran	pounds	25
Paris green or white arsenic	pound	1
Low-grade molasses	quarts	2
Oranges or lemons		3
Water	gallons	3½

Mix the bran and Paris green or arsenic thoroughly in a tub while dry. Squeeze the juice of the oranges or lemons into the water, chop the remaining pulp and the peel to fine bits, and add them to the water. Dissolve the molasses in the water and wet the bran and poison with the mixture, stirring at the same time, so as to dampen the mash thoroughly. This bait when flavored with oranges or lemons was found to be much more attractive to the grasshoppers than that prepared without fruit of any kind.

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[1] This discussion of insects and methods for their control has been contributed by the Bureau of Entomology.

The poisoned bran should be scattered, at intervals of several days, about the field in open places where the insects are most abundant, so that there will be fresh bran for the grasshoppers to feed upon until their numbers are reduced sufficiently to save the crop. Only community action can make this war on the grasshoppers effective, as they will migrate from a field on which the crop has been destroyed to fresh fields as soon as their supply of food becomes scarce.

Other insects which have been known to attack millet, but which are not of any great importance, are flea beetles, wireworms, and the southern corn rootworm.

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CITRUS-FRUIT IMPROVEMENT

HOW TO SECURE AND USE TREE-PERFORMANCE RECORDS

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FARMERS' BULLETIN 794

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. **February, 1917**

MANY California citrus growers have reported in recent years that they were securing lower yields of fruit per acre than in the earlier history of their industry. Complaint also has been made that an increasing proportion of the fruit of the leading commercial varieties of oranges and lemons was abnormal or "off type" in size, form, color, smoothness of skin, or other important characteristics.

Systematic and continued investigation of this subject in the groves in California since 1909 has disclosed that a considerable proportion of the deterioration observed is traceable to unintentional propagation of undesirable strains of the leading varieties resulting from bud variation.

The results obtained in bud-selection experiments carried on during the past five years indicate that by top-working with buds from those having consistently good records for productiveness and quality the inferior or "drone" trees of such varieties as Washington Navel and Valencia oranges can be made productive and profitable.

This bulletin describes the methods that have been found effective and practicable in locating the desirable and undesirable trees in groves and for transforming the latter when found.

CITRUS-FRUIT IMPROVEMENT: HOW TO SECURE AND USE TREE-PERFORMANCE RECORDS.

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INTRODUCTION.

The established and proved citrus varieties are the most valuable possession of the citrus industry. The conservation, standardization, and stabilization of these varieties should receive most careful consideration by citrus propagators and growers.

The deterioration or "running out" of these varieties through the unintentional propagation of undesirable strains is responsible for a large proportion of the low yields of inferior fruits in many citrus orchards. The introduction of new varieties to take the place of those which have become unprofitable by reason of the use of careless methods of propagation is usually a matter of experiment. The establishment of new varieties requires long periods of time to prove their value to the grower and to introduce them in the markets.

The use of individual-tree records of production in citrus orchards was originally introduced into California by the writer in 1909. The utility of such records as a factor in the practical work of standardizing the quality and quantity of fruit production in established orchards has been proved experimentally and tested commercially. As a result of these investigations thousands of nursery trees have been propagated and inferior trees in established orchards top-worked with buds selected from productive trees of desirable strains on the basis of their performance records for a series of years. Several thousand of these trees have come into bearing, and as far as can be determined from trees of their age they have without exception reproduced the strain which was propagated.

The data secured during a 6-year investigation of the nature and amount of bud variability occurring in Washington Navel orange trees in California will be presented and interpreted in another publication of the United States Department of Agriculture. The methods of commercial orchard practice recommended here are based on the results of that investigation.

The importance of individual-tree performance records as a basis for measuring the effects of cultural or other tree treatments, both in investigational and commercial work, has become so evident that such records are now regarded by the most efficient and successful California citrus growers as of great value in all orchard work. When making changes in methods of tree culture or care, the way to determine definitely whether such changes are of value is to secure performance records of the trees both before and after the new systems are put into practice. The increasing demand from growers for advice regarding a practical method of keeping individual citrus-tree performance records has made necessary the publication of this bulletin.

BUD VARIATION.

Although there is no generally accepted theory to account for bud variability in citrus trees, bud variation is of more or less frequent occurrence in trees of all varieties. It may manifest itself in the habit of growth of the trees or their method of branching, the size, form, texture, or color of the foliage, or the form, color, texture, abundance, or scarcity of the fruits. Occasionally one tree grown from a single bud will develop several distinct strains of fruit. Frequently a single fruit or a branch bearing several fruits will be found on a tree having characteristics distinct from the fruits of the typical strain borne by the tree as a whole. Minor variations in fruit characteristics are of very frequent occurrence.

Individual-tree performance records reveal the extent to which trees in commercial plantations differ from one another in their regularity of bearing and in the quality, quantity, and character of the fruit produced.

The nursery propagation of bud variations may be largely avoided through the use of buds selected from individual trees the performance records of which have shown them to be heavy annual producers of fruit of a desirable strain. Healthy citrus trees of inferior strains in established orchards may be successfully topworked to the best strain and may thus convert into an asset what was formerly a liability of the orchard.

THE OBJECT OF PERFORMANCE RECORDS.

The object of securing individual citrus-tree performance records is to obtain reliable information as to the behavior of individual trees in established bearing orchards. This information may be utilized in the elimination of inferior or drone trees by top-working or removing them, in the selection and location of particularly good trees for use as sources of bud wood for propagation, in studying the results of individual tree treatments, and for other purposes where it is important to know definitely the amount and value of fruit production. Individual-tree performance records enable citrus growers to replace indefinite and oftentimes unreliable opinions as to orchard conditions by exact and definite information, from which safe conclusions may be drawn.

METHODS OF SECURING THE RECORDS.

TREE NUMBERS.

The first step in securing individual-tree performance records is to number each tree, so that the record of the trees may be kept during successive years without danger of confusion and mistakes in securing and entering the performance-record data and other notes.

The numbering system evolved in the investigation of this problem has been adopted by many citrus growers. It provides for giving each tree a number consisting of three sets of figures. This individual tree number is made up of the number of the block or division of the orchard, the number of the row in which the tree occurs, and the position of the tree in the row, counting always from some fixed point, such as the irrigation head; for instance, a tree located in block 2, row 4, and the tenth tree in the row will have the number 2-4-10.

The numbers can usually be painted on the tree trunk or on one of the main limbs. It has been found most convenient to place these numbers in a vertical column, and they are more easily read when arranged in this form. Pure white-lead paint and an ordinary lettering brush should be used for this work. The numbers should always be placed in the same relative position on all of the trees in an orchard, so that they may be easily found at any time. Where it is not possible to paint the number on the tree it can be painted or stamped on a wooden or metal tag, which should be attached to the tree where it can be easily seen and in such a manner as not to interfere with the future growth of the tree. Large plain figures should be used, so that the number can be read from some distance. One man can usually number 175 or more trees in a day.

This system will prevent the duplication of numbers, no matter how many blocks or trees there are in the orchard; it will locate any particular tree, so that it can be easily found at any time for individual-tree care, for the consideration of its performance record, or for other purposes; and it will promote accuracy and simplicity in recording individual-tree data.

It seems advisable, in order to secure uniformity and accuracy in tree numbers, to advise the members of associations of fruit growers to have the numbers painted on the trees by a regular crew managed by the association, as is the practice at the present time in picking the crops. It can doubtless be arranged by most associations to have some members of the regular picking crew attend to the tree-number work before the regular picking season begins or during a slack period in that season.

PICKING.

The organization of the picking crew should be such that one man picks the fruits of an individual tree. The crew can usually be organized so that each picker is assigned to a row of trees. This arrangement frequently induces some rivalry among the pickers and will usually result in more rapid and efficient work than has heretofore been the case. Where tree records are not kept, two or more pickers as a rule work on the same tree, but this practice is not desirable where performance records are to be secured.

The picking boxes should be distributed to the individual trees instead of being assembled in box rows. A little practice will enable the distributors of the boxes to determine about the number of boxes required to hold the crop of each tree.

The picker should always empty his picking sack after finishing each tree, so as to avoid carrying any fruits to the next tree. The boxes, after being filled, should be assembled in the shade of the tree from which the fruits were picked in order to protect them from the sun.

WEIGHING.

The crop of fruit of each pick from an orange or grapefruit tree can be expressed in terms showing the number of full and partly filled boxes borne by the tree. In the case of lemon or lime trees, where frequent picks are usually made from each tree, the amount of each pick can be expressed in a manner similar to that for orange and grapefruit trees or, as is usually done, by determining the actual weight of the fruits and recording the results in terms of pounds.

Many citrus growers who are keeping individual-tree records in their orchards have found that a record of the number of full boxes and the estimated amount of fruit in the partly filled boxes is sufficiently accurate for their purposes. This method does away with the necessity for any apparatus for weighing the fruits. Where a considerable proportion of the crop of full-bearing trees is picked at one time this method of recording the amount of the yield of the individual trees will doubtless prove to be satisfactory. Where the amount of the pick from the trees is small, a more accurate record will be obtained by weighing the fruits.

A convenient method for determining the amount or weight of the fruit in the picking boxes is shown in figure 1. Figure 2 shows (at *A*) a shoulder harness, by means of which an inexpensive spring balance, *B*, is carried. The scale, *a*, provides for weighing a maximum of 50 pounds. The opposite scale, *b*, is calibrated by actual trials of empty and full picking boxes, the box tare being marked as 0 and the weight of a full box as 10. The space between these marks is divided into 10 equal parts, numbered from 1 to 10. Such an arrangement provides for determining the amount of the crop in the partly filled box either in terms of pounds or as tenth parts of boxes, as desired.

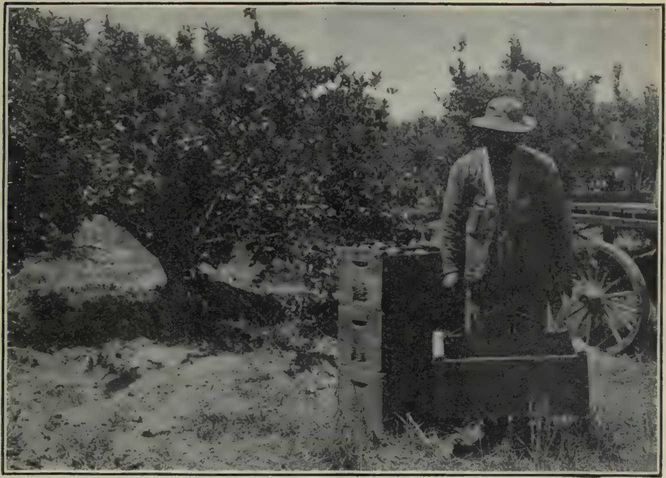
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FIG. 1.—Weighing citrus fruits in picking boxes for individual-tree performance records.

The ropes, *d*, are provided with steel hooks, *e*, so that they can be easily attached to the ends of the picking boxes. In using these scales the weigher attaches the hooks to the ends of the box, rises, assuming an upright position, thus lifting the box from the ground, and, with the box swinging free, reads the weight of the fruit.

A little experience with this balance will enable the weigher to secure accurate records of the amount of fruit in the picking boxes. In the case of a picking crew of 25 to 50 men the weigher will also have time to help inspect and distribute empty picking boxes, load the filled boxes on the orchard wagons, and perform such other duties as may be necsary to insure the careful handling of the boxes of fruit.

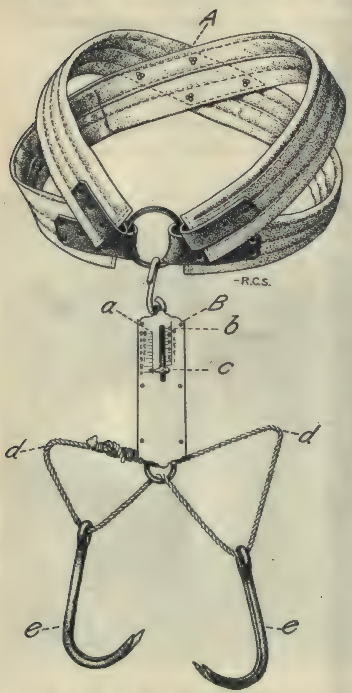

FIG. 2.—Details of the weighing apparatus shown in figure 1: *A*, Shoulder harness; *B*, spring balance; *a*, scale for weighing a maximum of 50 pounds; *b*, scale calibrated to indicate full box or parts of box in tenths; *c*, pointer; *d*, *d*, ropes; and *e*, *e*, steel hooks.

It has been found by experience that in order to secure reliable individual-tree records it is desirable to have one of the regular picking crew attend to this matter. In one large citrus planting, where individual-tree records have been kept for several years and the picking is done by crews of Mexican laborers, one Mexican in each crew keeps the records, inspects the empty picking boxes, and does such other work as is required in order to promote the careful handling of the fruits.

In other cases the foremen of the picking crews are expected to keep the individual tree records in addition to their other duties. This plan has been found to be less successful than where an extra laborer for each picking crew is provided for this purpose.

In association picking crews, where the crops of the individual members of the association are picked by a general picking crew, the individual-tree records can be secured in the smaller orchards by the simple expedient of adding one regular laborer to each picking crew. Any intelligent person can quickly learn how to keep the individual-tree records and assist in handling the fruits, so that the expense of the extra man can be justified from this standpoint.

RECORDING THE RESULTS.

The date of picking and the quantity and quality of the product of each tree should be recorded so that it can be easily classified and compiled for the intelligent consideration of that individual tree's behavior. The three forms shown herewith are suggested for the use of those who wish to keep such records. The successful use of similar forms in commercial performance-record keeping has proved their practicability. Experience with these forms has shown that a sheet of convenient size is one which provides space for recording the yields of 40 trees. These sheets should have a stiff-back loose-leaf cover or be perforated and bound in covers to facilitate their use in the orchard and to make it possible to assemble the records of any particular block.

The form recommended for keeping orange and grapefruit individual-tree performance-record data for a maximum of four picks in one season from each tree is shown in Table I, *A*.

The form recommended for use in keeping individual lemon and lime tree performance-record data, providing for a maximum of 12 picks each season, is shown in Table I, *B*. In this form provision is made for recording the quantity of fruit, either in terms of pounds or as the number of full and partly filled boxes, for a maximum of 12 picks from each tree during the season.

The commercial grade of the fruits of the individual trees can be recorded by the use of the following or a similar system: *A* may be used to designate the best or first-grade fruits; *B*, inferior, blemished, or second-grade fruits; *C*, cull or third-grade fruits; and *S*, extremely variable fruits as regards shape, size, color, or other characteristics. This system can be extended, if desired, to cover other matters of importance in individual-tree care, as, for instance, the letter *X*, to call attention to particularly good trees which may be found suitable for the selection of bud wood for propagation; *D*, to suggest diseased or injured trees; *F*, to mark such trees as may need fumigation; *P*, to show the need of pruning; *T*, to indicate an undesirable tree which should be top-worked or removed; and such other letters or symbols can be employed as may be of value in systematic individual-tree care.

TABLE I.—*Forms for keeping individual-tree performance records for citrus and similar fruits.*

[The three forms here reproduced as samples, marked respectively A, B, and C, are necessarily shown somewhat abridged as to number of trees, simply for economy of space. In actual use, each form is to occupy a full sheet, and a length sufficient to record the yields of 40 trees is recommended.]

FORM A.—ANNUAL TREE RECORDS OF ORANGE AND GRAPEFRUIT ORCHARDS FOR A MAXIMUM OF FOUR PICKS DURING THE SEASON.

Block No.............................. Age of trees.............................. Season.............................. Variety..............................
Row No.............................. Trees per acre.............................. Grove.............................. Location..............................

Tree.	Dates of picks.												Yield for season.		
	Boxes.	Part boxes.	Grade.	Boxes.	Part boxes.	Grade.	Boxes.	Part boxes.	Grade.	Boxes.	Part boxes.	Grade.	Total.	Average grade.	Notes.
No. 1															
No. 2															
No. 3															
No. 4															
No. 5															
No. 6															
No. 7															
No. 8															
No. 9															
No. 10															
No. 11															
No. 12															
No. 13															

FORM B.—ANNUAL TREE RECORDS FOR LEMON AND LIME ORCHARDS.

Block No.................... Age of trees.................... Season.................... Variety....................
Row No.................... Trees per acre.................... Grove.................... Location....................

Tree.	Dates of picks.												Yield for season.		
	Amt.	Amt.	Amt.	Amt.	Amt.	Amt.	Amt.	Amt.	Amt.	Amt.	Amt.	Amt.	Total.	Grade.	Notes.
No. 1..........															
No. 2..........															
No. 3..........															

FORM C.—PERIOD CITRUS-TREE RECORDS.

Block No.................... Age of trees.................... Season.................... Variety....................
Row No.................... Trees per acre.................... Grove.................... Location....................

Tree.	Season.												Total for .. years.			Treatment of tree or other notes.
	191...			191...			191...			191...						
	Boxes.	Part boxes.	Grade.	Boxes.	Part boxes.	Grade.	Boxes.	Part boxes.	Grade.	Boxes.	Part boxes.	Grade.	Boxes.	Part boxes.	Average grade.	
No. 1..........																
No. 2..........																
No. 3..........																
No. 4..........																

The data showing the total yield of each tree and the related notes should be transferred to a period citrus-tree record form, such as is shown in Table I, *C*. This form provides for bringing together the records of several successive seasons, so that the behavior of each tree during a given period may be studied and compared with that of other trees grown under similar conditions. The number of seasons' records necessary for this purpose varies somewhat according to the conditions, but in all cases an even number of seasons' records is desirable. As a rule, the records of full-bearing trees for two successive normal seasons have been found to be a sufficient basis for determining the relative value of individual citrus trees for commercial fruit growing. The records of four successive normal seasons will probably be adequate for use as a basis for the selection of parent trees as sources of bud wood for propagation. In any event two years' experience will demonstrate to every grower the importance of individual-tree records, from which he can easily draw his own conclusion as to length of the period he should keep these records. So far in the cooperative work of this character not a single grower has dropped the individual-tree record work after having started it, and some of the records now cover a period of six years.

THE USES OF PERFORMANCE RECORDS.

BUD-WOOD SELECTION.

Citrus bud wood for commercial propagation should be cut only from the best trees of the most valuable strain. These trees should be selected on the basis of their performance records and from intimate individual-tree knowledge.

Only fruit-bearing bud wood should be used for propagation. Every bud stick should have one or more typical fruits attached, if possible, when cut from the select parent trees, as shown in figure 3. By the use of this method more buds can be secured from productive and desirable trees than from unproductive and undesirable ones. Such bud wood has been found to produce trees of satisfactory growth, as well as early and regular yields of fruit.

In the past, sucker growth has been generally used for propagation, and little or no attention has been paid to the number or quality of the fruits borne by the trees from which bud wood has been secured. This practice has naturally led in many cases to the propagation of inferior strains. The large proportion of trees of undesirable strains in many citrus orchards is due to this lack of care in the selection of bud wood.

TOP-WORKING UNDESIRABLE TREES.

The elimination from established orchards of trees of undesirable strains has been effected by top-working these trees with select buds from trees of a desirable strain.

While trees of some of the inferior strains can be recognized from their habit of growth or other vegetative characteristics, it is desirable wherever possible to make the final selection of trees to be top-worked on the basis of their performance records and the characteristics of the fruits borne by them.

The selection of the bud wood for top-working purposes was based on individual-tree performance records and an intimate knowledge of tree characteristics secured by careful observation.

The first top-working on a commercial scale, as a result of the bud-selection investigations of the Department of Agriculture, was done in the summer of 1911. In a 235-acre orchard of 8-year-old Eureka lemon trees, approximately 2,500 trees of inferior strains were top-worked with buds from carefully selected trees in the same orchard.

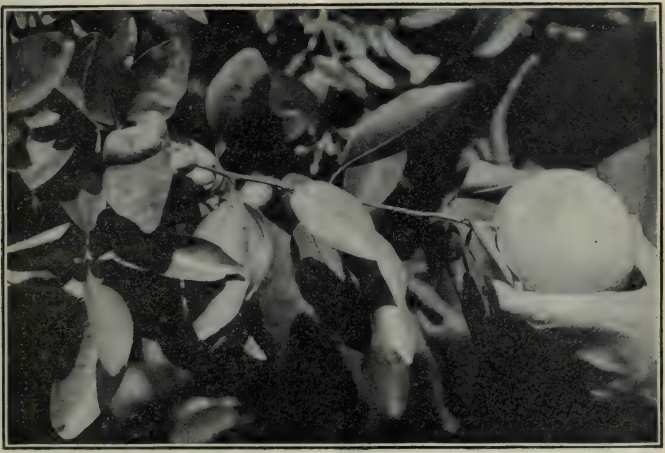

FIG. 3.—Typical fruit-bearing citrus bud wood recommended for use in propagation.

Notwithstanding the extremely cold weather of the succeeding two winters, which very seriously injured the growth from these buds, the rebudded trees are at the present time as productive as the other trees in the orchard, and without exception the strain which was propagated has been reproduced, as far as can be determined from trees of their age. Each year since that time several thousand trees in various citrus orchards in California have been budded or top-worked on the same basis, and those which have reached bearing age have reproduced the characteristics of the strain which was propagated.

CARE OF BUD WOOD.

Citrus bud wood should be used as soon as possible after it is cut from the select parent trees. If it is necessary to keep the bud wood for some time before it is used, it should be packed in moist, sterilized sphagnum moss and stored in a cool room having fairly uniform conditions of temperature and humidity. The ideal conditions for such a room are a temperature of about 70° F. and a relative humidity of 80 to 90 per cent. The moss used for packing the bud wood should be thoroughly moistened and sterilized with live steam for about an hour, after which it can be run through an ordinary clothes wringer in order to squeeze out all of the excess moisture. Under proper storage conditions citrus bud wood can be kept in good viable condition for several months.

BUDDING.

The most favorable time for budding is generally during the spring months. However, budding can be done successfully at any time during the growing period of the trees. With some varieties budding in the late fall is preferable to summer budding, as the buds will remain dormant in the stocks until the following spring and the young, tender growth of the buds will not be subjected to the extreme climatic conditions of the winter months. High budding—that is, the insertion of the buds as high on the stocks as possible—is recommended for California conditions.

In top-working undesirable trees, two or more of the main limbs should be selected as the foundation for the new head, as shown in figure 4. The select buds should be inserted in these limbs, two or more in each, about 1 to 2 feet from the trunk of the tree. After the buds have made a union with the tree, the limbs should be sawed off about 6 inches above the inserted buds. The freshly cut surfaces should be covered with grafting wax, pure lead paint, or some pruning compound, and the remainder of the tree should be covered heavily with whitewash, cloth, or other material, so as to protect the trunk and limbs of the tree from sun scald or other injuries due to exposure. After about a year's growth the limbs should be cut back again, so that only one bud is left on each. These second cuts should slope downward from a point directly above the bud union, and the surfaces should be again protected, so they will heal completely.

Top-worked trees should be inspected frequently for the first two or three seasons and all growth removed except that from the select buds. In one or two years the growth from such buds will begin bearing fruits and should reach normal production in from three to five years, depending on the variety and the climatic and cultural conditions.

SUMMARY.

Bud variation in citrus fruits is of more or less frequent occurrence and of great economic importance to citrus growers.

The investigations now under way indicate that undesirable bud variations can largely be eliminated from commercial citrus plantations by using bud wood from trees known to continuously produce fruit of the character desired. The determination of these trees is most easily and satisfactorily made through the keeping of performance records.

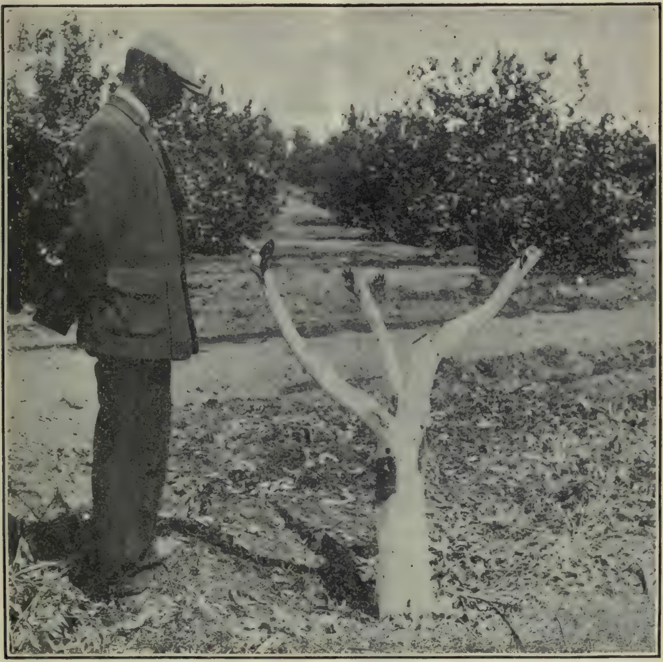

FIG. 4.—A Eureka lemon tree of an unproductive strain 10 years old, rebudded to a productive strain, showing the first growth of the buds previous to the final cutting back of the foundation limbs.

Individual citrus-tree performance records are being kept by many citrus growers.

Records for an even number of successive seasons are desirable. For some purposes two seasons' records of full-bearing trees are probably sufficient; in other cases four or more seasons' records are preferable. The longer the period during which performance records are kept and the greater the number of trees recorded, the more valuable the records become.

These tree records enable the growers to locate good trees from which bud wood may be secured, poor trees to be top-worked with select buds, and trees needing individual care. They also provide reliable data on which to base conclusions concerning the results of tree or orchard treatments.

Each tree in the orchard should be given a number, by means of which it can always be identified and easily found.

The work of weighing and recording the crops of the individual trees can be done with little extra expense by adding one laborer to each picking crew. This cost is small when considered in connection with the value to the grower of the information obtained thereby.

Only fruit-bearing bud wood should be used in propagation. This bud wood can be used immediately after cutting, or it can be kept in moist, sterilized moss in a cool room for several months.

The spring period of tree growth is usually the best time for budding.

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THE
DOMESTICATED SILVER FOX

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FARMERS' BULLETIN 795
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Biological Survey
E. W. NELSON Chief

Washington, D. C. March, 1917

FOX FARMING, or as it is called in Canadian Provinces, "fox ranching," has attracted wide notice chiefly because of the enormous profits claimed for it. As would be expected in the case of a new and profitable business, many erroneous impressions have been entertained, the result of misleading statements made partly through lack of authentic information and partly with the purpose of interesting investors. When rightly undertaken, however, and with due consideration to climate, surroundings, and breeding stock, fox farming, and especially the breeding of silver foxes, frequently has proved profitable.

In the following pages are considered facts relative to the development of silver fox farming; the precautions necessary to be taken with the animals in breeding and in sickness and health; the construction of inclosures and nesting dens; the expenses of the business as well as its profits; and, in general, how and where fox farming may be undertaken with the promise of any degree of success. The distinction between red, cross, silver, and black foxes is explained and the relative values of the pelts discussed.

The softer and more beautiful furs naturally bring the higher prices, and few wild fur-bearing animals surpass the silver fox in this respect.

The lessening numbers of the animals in the wild state together with the increasing demand for their furs sound a warning that if this demand is to continue to be met it must be through domestication.

In certain cool climates the animals may be reared in captivity just as are domestic cattle and poultry. The areas suitable in the main for experiments in silver fox farming may be ascertained by reference to the map and its explanation on page 8.

THE DOMESTICATED SILVER FOX.

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INTRODUCTION.

From time immemorial furs have been worn for protection and adornment. With the increase of population and of encroachments upon the breeding grounds of fur-bearing animals the supply of furs has steadily diminished and prices have correspondingly advanced. Trappers have been stimulated to penetrate farther and farther into the uninhabited regions of the North and to redouble their efforts to increase their catch nearer home. Many of the more valuable animals have thus become so scarce that the demand for their pelts is met by the substitution of inferior products.

The natural production of first-class furs seems to be approaching a sure end, and the demand for them requires that the present supply be supplemented through domestication of fur-bearing animals. As some of the fur bearers may be raised without much difficulty, the establishment of fur farming on a small scale may be expected in many places along our northern border, much as poultry is now raised as an additional source of income on farms. When properly conducted, fur farming may become very profitable. It will pay not only in direct returns to the producer, but, indirectly, the desire for furs can be gratified, the killing off of the most valuable and interesting of our fur bearers prevented, and an extensive branch of manufacture and trade supporting a large population continued.

NOTE.—This bulletin, based on Department Bulletin No. 301, "Silver Fox Farming in Eastern North America" (1915), has been prepared to supersede Farmers' Bulletin No. 328, "Silver Fox Farming" (1908). It is for general distribution in areas shown by shading in the map on page 8.

The first American fur animal to be domesticated permanently was the silver or silver-gray fox (fig. 1), a rare and beautiful color phase of the common red fox[1] found in nearly all of the United States and Canada.

The relation of silver foxes to ordinary red foxes is the same as that of black squirrels to gray squirrels, or black muskrats to brown muskrats. That is to say, the black individuals are of the same species as those having the regular color. In a litter of fox cubs born of red parents, perhaps there may be one silver. On the other hand, one or more of the cubs of a wild silver vixen are quite certain to be red. Fortunately, experience has shown that when silvers are bred in captivity the tendency to produce reds can be overcome by selective breeding.

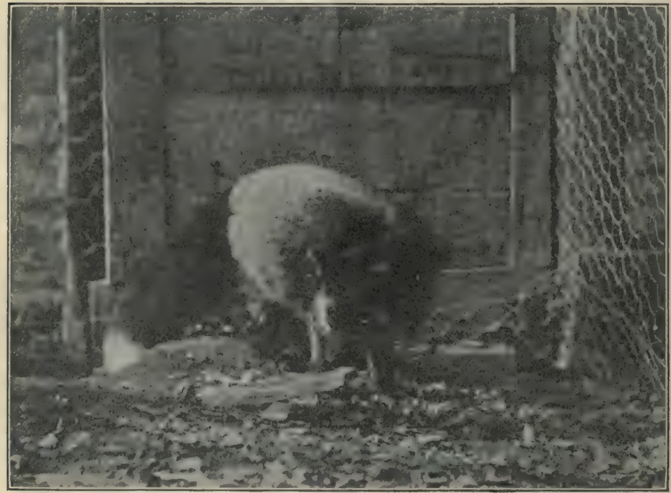
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FIG. 1.—A silver fox bred in captivity. Note the tip of the tail, which is white in all phases of the ordinary red fox.

The average red fox has the throat, breast, and belly white, and the sides and upperparts mainly red, this color being pure across the shoulders and on the nape of the neck but sparsely mixed with white on the back and sides. Close inspection discloses that the red and white are only on the surface, and that the fur beneath is almost black on the upperparts and dusky gray on throat and belly. It shows also that the fine hair or wool constituting the underfur is tipped with red and that, as a rule, the coarse guard hairs have a white section a little below the tip. Occasionally a guard hair is found that is entirely black. In the typical silver fox black replaces the red of the ordinary fox, the white of the guard hairs on the upperparts remaining constant. The result is a beautiful black, overlaid by a sprinkling of silvery white. Between the red and the silver phases there are grades of every degree, ranging from red-backed animals with black underparts through conditions characterizing cross foxes and rusty silvers. In rare instances even the white bars of the guard hairs are displaced, the result being a black or a silver-black fox. In general, the cross fox is fairly common, the silver-gray scarce, and the pure black very rare.

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[1] Genus *Vulpes*.

The market value of skins of the different phases depends upon the relative scarcity of the animals. The price paid for black skins, however, has recently fallen considerably below that of silvers, for the reason that furriers now dye ordinary red fox skins a lustrous black and put them on the market at a comparatively low figure.

HISTORY.

Domestication of the fox was first achieved in the Canadian Province of Prince Edward Island, in the Gulf of St. Lawrence. Silver fox pelts have continuously commanded high prices, and hunters have been correspondingly keen to secure them. It is not strange, therefore, that the first successful breeders of this rare animal were men who had pursued it in the chase.

In 1894 a ranch was built and stocked with two pairs of silver foxes. This became the first profitable fox ranch, the forerunner of a remarkable and, for that region, a revolutionizing industry.

At that time black pelts brought much higher prices than silvers. This prompted the first fox ranchers to retain their darker animals and dispose of the lighter ones, and as a result each successive lot of pelts from their yards was darker than those of previous years. Finally, in 1910, they were able to send to the London sales the finest collection of silver fox pelts that had ever appeared there. This lot, containing 25 pelts, brought an average of $1,386 each, the best one selling for $2,624. In the meantime a few other small ranches had been started in the Maritime Provinces, Newfoundland, Maine, Ontario, Michigan, and Alaska. The policy of the half dozen Prince Edward Islanders had been to monopolize the business, and not even their families were enlightened as to their methods. The pelts had been shipped three in a package by parcel post from a distant post office, and reports of the sales had been received in code. The fox raisers had entered into a compact to sell no live silver foxes and had bought the best that could be obtained. Notwithstanding their secrecy, the evident improvement in their financial conditions was noticed by their neighbors, who thereupon desired to participate.

Disclosure of the results of the 1910 sales was the climax of the first stage in the development of fox farming. Persons who formerly had known something of the business were now eager to engage in it. Those having money invested it in foxes. Others mortgaged their farms for the purpose or fitted up ranching facilities and boarded foxes for a share of the progeny. How rapidly prices for breeding stock advanced is well illustrated by the experience of one ranchman who sold his first pair of cubs for $750, and other pairs successively for $3,000, $12,000, $13,000, and $14,000. In the fall of 1913 good ranch-bred cubs 6 months old sold for from $11,000 to $15,000 a pair. Pairs that had had large litters were valued at about twice as much as 6-months-old cubs.

The maintenance of this prodigious inflation of prices was due mainly to stock companies, which originally were formed by individuals without sufficient capital to engage in fox farming alone. Almost immediately, however, companies were formed for the benefit of those having foxes to sell. Attractive prospectuses containing pictures of silver foxes, an account of the 1910 sale of pelts, and a list of companies which had paid dividends of 20 to 500 per cent were published, and stock sold through brokers and solicitors. Foxes that would bring $12,000 or $15,000 a pair in the open market were usually capitalized in companies at $18,000 or $20,000, which, after allowing for commissions, installation of pens, and other ranch necessities, left a tolerably safe balance from which to pay the first year's running expenses. Another reason for the multiplication of fox companies is found in the income to be derived from them by brokers and promoters, and many companies were formed by men having no other interest. The outbreak of the European war, in the summer of 1914, interrupted and possibly ended these speculative operations. Ranch-bred silver foxes have recently been advertised for sale at from $500 to $1,000 a pair. In some of the western Provinces and Territories of Canada, where only those foxes born or kept for a year or more in captivity are allowed to be exported, prices of wild half-grown silvers run from $150 to $250 each.

In the pioneer days, when proper methods of handling foxes were unknown, many failures resulted from ignorance and carelessness. The excitement following the fur sales of 1910 hastened the improvement of methods of feeding, handling, and breeding. It also broke the monopoly, and caused a rapid distribution of foxes and of information concerning them. Now, with a comparatively large number of silver foxes in domestication, with a clearer understanding of their successful management, and with a return of moderate prices for breeders, a steady, healthy, and general development of silver fox farming may be expected.

Fox ranches are now established in most of the Canadian Provinces and in Maine, New Hampshire, Vermont, Massachusetts, New York, Pennsylvania, Ohio, Wisconsin, Michigan, Minnesota, Missouri, Oregon, Washington, and Alaska.

CLIMATE.

Fur growth is intimately related to climate. A long cold season and at least a moderate rainfall are important. Hot summers are not detrimental if short and followed by a season of frosty weather during which animals renew their coats. Dry winds tend to make fur harsh, and excessive sunshine fades it. The fitness of a locality for fox farming can be judged from the quality of fur produced by native wild foxes. While the proportion of silvers to reds varies greatly in different regions, this variation does not appear to depend on climatic conditions, and need not be considered in locating a fox farm.

The map of life zones shown in figure 2 indicates the regions having an average temperature favorable to fur culture, the cooler Canadian Zone being superior to the Transition Zone. Much of the region west of the Great Plains is included within these life zones on account of its high altitude, which makes it as cold as lower areas much farther north. While parts of this region possess the requisite degree of cold they are too dry and sunny for the production of first-class fur.

SITES.

One of the most important considerations in the choice of a site for a fox ranch is security from unusual noises and occurrences. The fox is naturally timid and nervous. It can be tamed to a degree, but its excitable temperament can be completely overcome only by a long process of careful breeding and selection. It is especially shy and irritable during the breeding season.

Foxes like to be screened from observation, and by day in the wild state are rarely found far from cover. During the heat of summer, especially, they enjoy dense shade. Furthermore, sunshine injures the color and character of fur. It is advisable, therefore, to locate a ranch among a growth of young trees thick enough to shade about half the ground. Deciduous trees are preferable to evergreens, as they allow the sun to make the yards more comfortable in winter and to clear the ground of snow earlier in spring. Old trees are likely to be broken by storms, and in falling to demolish fences.

On a slope with a southern exposure the snow will be gone and the ground warm when the cubs are ready to leave the dens. A clay surface is to be avoided, but a subsoil of clay or hardpan is an advantage, as the foxes will not dig ground hard enough to require a pick to break it up. Gravel affords excellent drainage, but foxes burrow deeply in it and thus are difficult to manage, even though they may not escape.

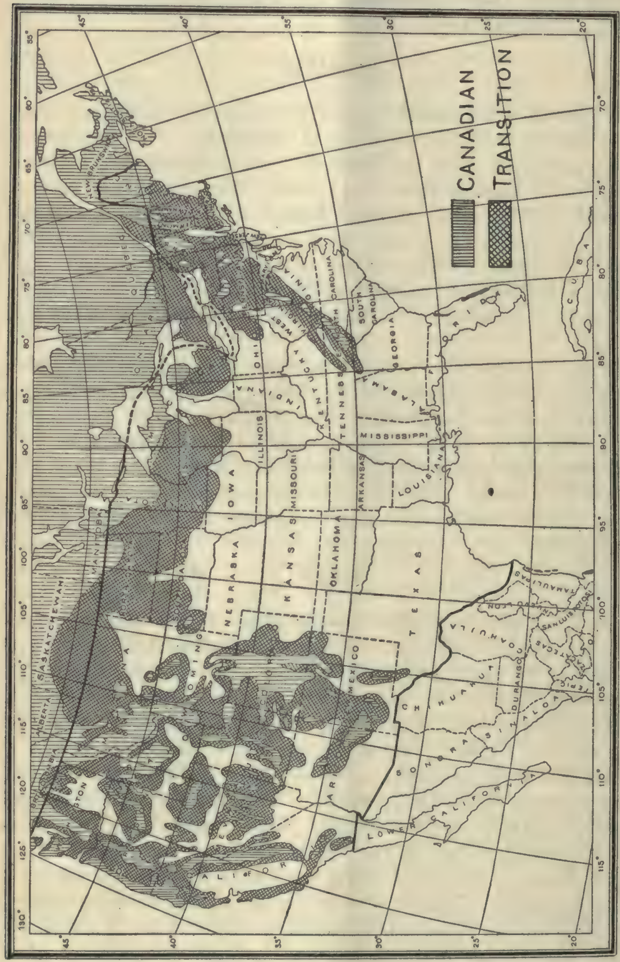

FIG. 2.—Map of life zones in which fox farming is feasible in the United States, showing the Canadian Zone, where conditions are excellent, and the Transition Zone, in parts of which conditions are favorable.

INCLOSURES.

A model fox ranch has three kinds of inclosures—dens in which the animals are sheltered and the young are born; yards or runs, where they may have sunshine and shade and sufficient exercise to keep them in good health; and a guard fence surrounding the entire ranch, for the double purpose of preventing intrusion from without and escape from within.

DENS.

The walls of a fox den should exclude moisture, deaden sounds, and protect the occupants from extremes of heat and cold. During the breeding season, when foxes are unusually nervous and when the cubs can not withstand exposure, these features are particularly important. Provision should also be made for ventilation without admitting light or drafts. The barrel den shown in figures 3 to 6 is merely a clean barrel, having a smooth interior, surrounded by dry sawdust, within a wooden box. In one head of the barrel is an entrance hole 8 inches wide and 10 inches high. A similar

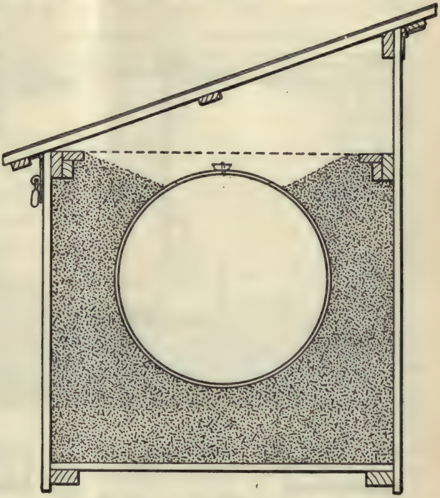
FIG. 3.—Vertical cross section of a barrel den.

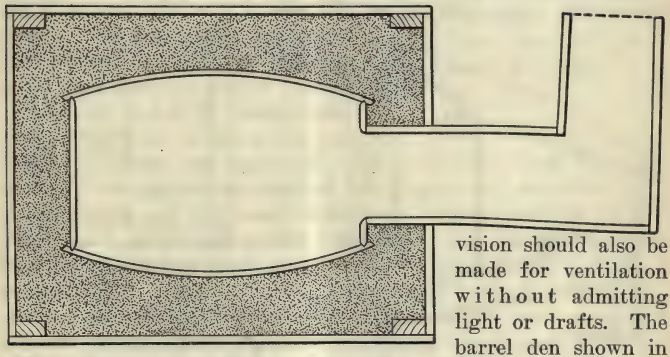
FIG. 4.—Horizontal longitudinal section of barrel den.

opening is made in the upper side for inspection, cleaning, and ventilating. Above the barrel a screen door is hinged to preclude escape when the cover is raised. A sheet of burlap tacked to one side of the screen-door frame and spread over the netting when the covers are raised for ventilation will keep out air currents and light. At the entrance hole is an elbow spout, 2½ feet in the shorter arm and 6 feet in the longer.

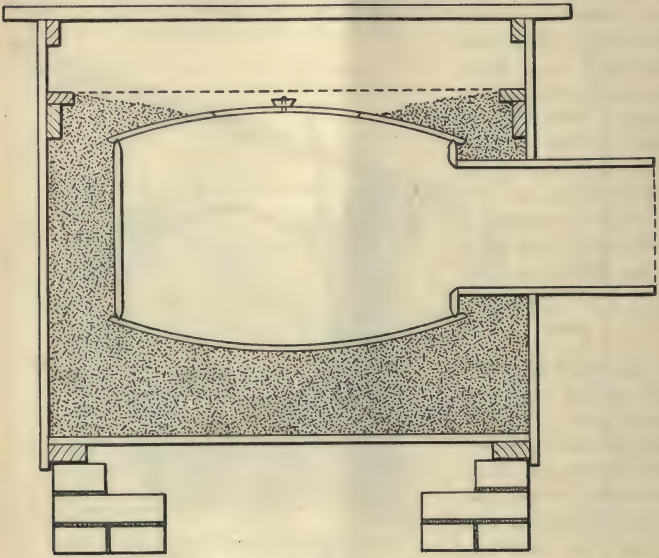

Fig. 5.—Vertical longitudinal section of barrel den.

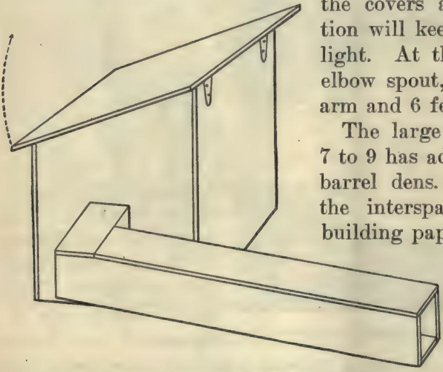

Fig. 6.—Exterior view of a barrel den (see figs. 3–5).

The large den shown in figures 7 to 9 has advantages not found in barrel dens. It has double walls, the interspaces being lined with building paper and filled with sawdust. The exterior may be battened, shingled, or covered with tarred paper. It is large enough to give the foxes lounging room outside the nest compartment, and is arranged so as to be easily cleaned and disinfected. By leaving the door open on fine days the interior can be exposed to the drying and purifying effects of sunshine. The door and the opening to the exit chute should face southward, and the rear end should be raised enough to give the floor a slant downward toward the door. The entrance to the nest compartment and the inner end of the chute should be about 4 inches above the floor to prevent the cubs from getting out before they are able to return.

The corners along the floor and sides of the nest compartment are filled with a chamfered strip of board (figs. 7 and 8) to keep very young cubs in contact with the vixen and thus prevent their becoming chilled. To accommodate a large family of cubs running about the yard, it is advisable to have extra dens improvised from barrels or boxes, as shown in figures 10 and 11. Such shelters increase the diversity of the yard and afford the animals more protection from the weather.

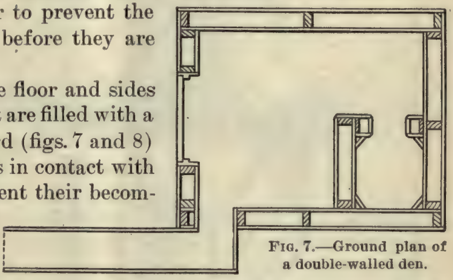

FIG. 7.—Ground plan of a double-walled den.

As to the proper location of a den, opinions differ. Some place it near the middle of the yard (fig. 12), where the foxes are supposed to feel more secure. Others locate it outside the yard, in order that the vixen may not jump to and from the roof and thus cause abortion. All dens placed outside of yards should have an inner door of wire netting if they open to an alley.

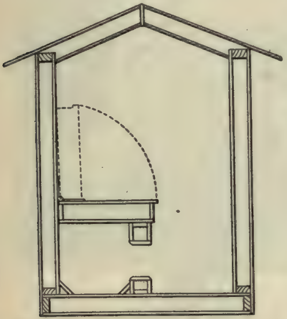

FIG. 8.—Vertical cross section of double-walled den.

YARDS.

Although fox yards vary in size, shape, and construction, depending on conditions on different ranches, there is a definite type now generally recognized as best adapted to fox farming. Such a yard has an area of from 2,000 to 2,500 square feet. The majority in the recently built ranches are 50 feet square. Some breeders prefer long, narrow yards, which give the foxes more space for a hard run when they are frolicsome, though the cost of fence materials is considerably greater than for square yards of the same area. The arrangement of a series of yards depends upon the space they are to occupy. When arranged as nearly as possible in the form of a square the expense of inclosing by a guard fence is less than when side by side in a row. Two plans of four-yard ranches are shown in figures 13 and 14, the smaller compartments being for males. The expense for posts and scantlings in building a ranch on the plan of figure 13 is less than for the plan of figure 14, inasmuch as adjacent yards have a common frame between them.

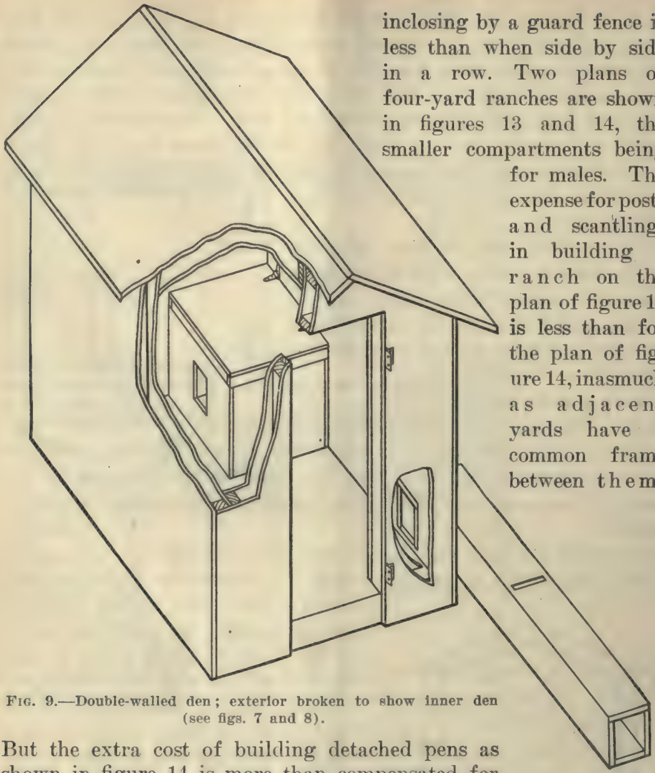

FIG. 9.—Double-walled den; exterior broken to show inner den (see figs. 7 and 8).

But the extra cost of building detached pens as shown in figure 14 is more than compensated for by the greater convenience in caring for the animals and in controlling them in case they escape from their yards. If a fox gets out of its yard, it is sure to be discovered in one of the alleys, whence its return to its proper quarters is a simple matter.

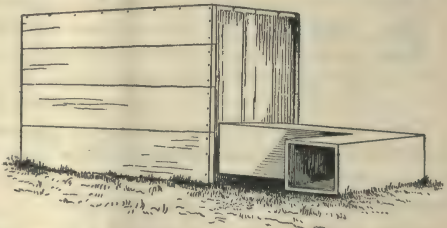

FIG. 10.—Den improvised from a box.

The supports of a fence are ordinarily wooden posts, set in the ground at intervals of from 12 to 16 feet. The heaving effect of frost, however, has caused many fox owners to abandon them for a framework of scantlings entirely above ground. The foundation may be of stone, concrete, or cresoted planks. The posts of framed fences are tied together by the netting and braced from the ground as shown in figure 15. A durable and attractive fence support recently adopted by several fox owners is shown in figure 16. It has a concrete foundation 4 feet deep, 9 inches thick at the bottom, and 6 inches thick at the top, and projects slightly above ground. In this are embedded posts of 1-inch galvanized-iron pipe. Tie-rails of $\frac{3}{4}$-inch pipe connect these posts at the top and also just above the foundation.

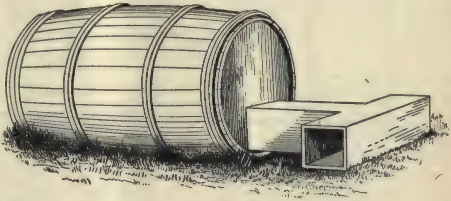

Fig. 11.—Den improvised from a barrel.

Wire netting for fox-yard fences has been in use from the beginning. It allows free circulation of air and permits the animals to take an active interest in their surroundings and in one another. The netting ordinarily used is like that for poultry runs, except that the wire is heavier. It may be of 2-inch mesh in 14, 15, and 16 gauge. The lower part of a fence should be made of the heaviest wire obtainable, the lighter grades being used for the middle and upper parts. As very young foxes are likely to become entangled in 2-inch netting or even to go through it, many fox breeders use only $1\frac{1}{2}$-inch mesh. Those having 2-inch mesh usually reinforce it from 6 inches above the surface of the ground to 6 inches below it with boards or a strip of 1-inch netting.

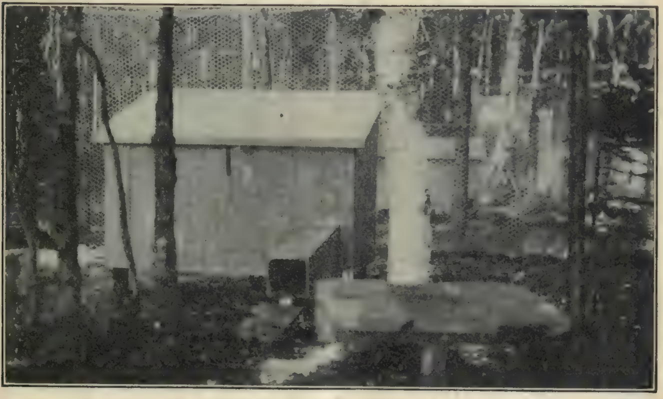

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Fig. 12.—An inexpensive type of den. Table in foreground is for the food of parent foxes; by means of it young cubs are prevented from obtaining too much meat.

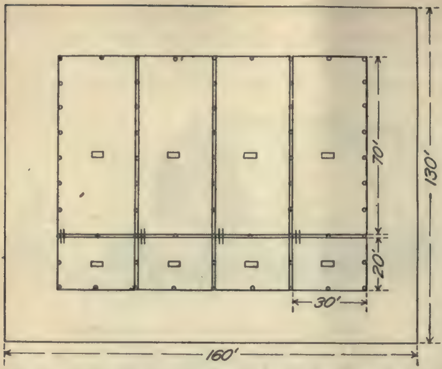


FIG. 13.—Plan for rectangular yards in series; dens with yards.

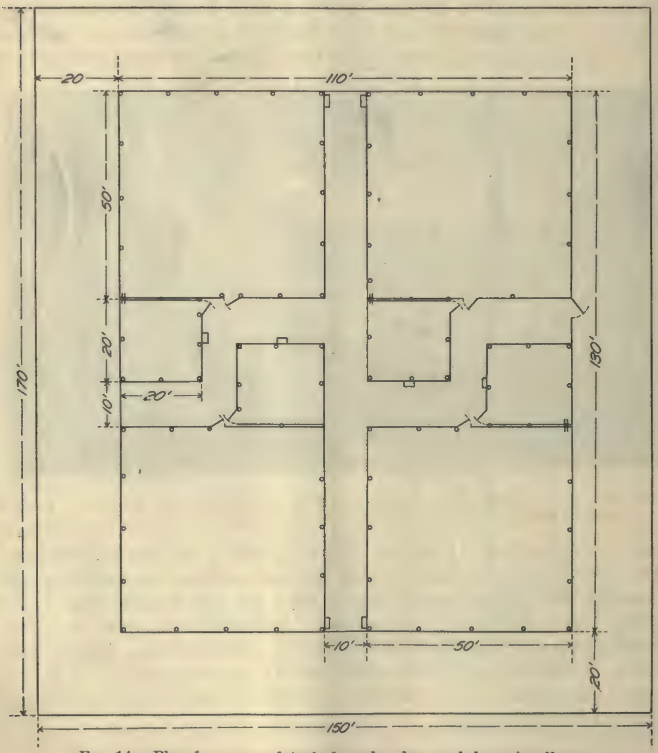
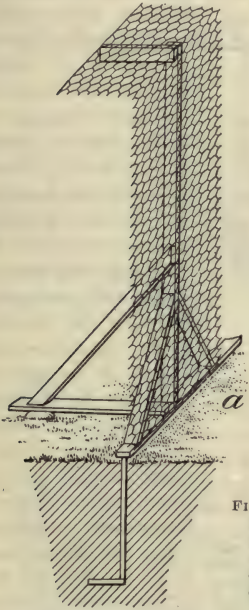


FIG. 14.—Plan for square detached yards; dens and doors in alleys.

The disposition of foxes to take an adversary at a disadvantage has led to serious injuries when adjoining yards were separated by only a single partition of coarse netting. In a number of instances a climbing animal has had its foot seized, pulled through the fence, and held by the occupant of the next yard until its frantic struggles to escape resulted in a badly mangled leg. Such accidents can be avoided by making double-walled partitions, the walls separated by at least 4 inches, or single-walled partitions of 1-inch netting or of boards. The necessity of erecting double partitions is overcome, however, by use of the plan illustrated in figure 14.

The height of a fence depends somewhat upon the depth of the snowfall. In Maine and the Maritime Provinces the usual height is 9 or 10 feet, while in Laborador it is 12 feet. To prevent foxes from digging out, the fence is either extended into the ground (fig. 17) or turned abruptly inward at the surface (fig. 18) to form a mat 3 feet wide, the inner edge of which is pinned firmly to the ground and usually covered with earth or stone. A fence extended into the ground must reach a depth of 4 or 5 feet if the soil is soft, and be turned inward a foot at the bottom. If there is a subsoil of clay or hardpan, the fence need not enter it more than 6 inches. Instead of netting, the underground part of a fence may be made of 2-inch creosoted planks. As foxes climb wire fences readily an inward overhang about 18 inches wide should be placed at the top to prevent escape (figs. 15–20). When a fox has scrambled up to an overhang,



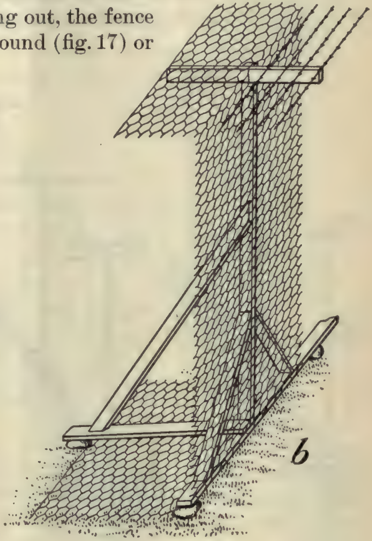


FIG. 15.—Sections of yard and guard fences, with frame supports. The yard fence, *a*, has a foundation of creosoted planks. The guard fence, *b*, rests on stones and has a mat to prevent foxes from digging out, and an outward overhang to keep out dogs and other intruders.

its only means of descending is by falling. Sometimes valuable animals have been seriously injured in this way. To prevent accidents of this kind an intermediate overhang is sometimes constructed 5 feet from the ground, as shown in figure 16, or a smooth zone of boards or sheet iron is inserted in the upper half of the fence, as shown in figure 20.

The yards for sequestering males are usually adjacent to the main yards, with which they are connected by a chute having a sliding door (fig. 21), though sometimes they are separated from the family yards. It is advisable to have them roomy, as indicated in figures 13 and 14, in order to give the animals enough runway to make them vigorous during exile. When allowed to be together the pair may have the run of both yards. Although quarters for constant occupancy should be roomy, those for temporary use, such as are required by dealers and ranchmen for isolating sick or newly arrived animals, may be comparatively small. Temporary pens are often not more than 6 by 10 feet on the ground and 4 or 5 feet high. They are made with netting on top, bottom, and sides, stretched over a frame of scantlings. The posts do not enter the ground, but rest upon sills, to which they are securely nailed. By means of braces the frame can be made rigid, and when covered with netting is strong enough to be moved without weakening. The cheapness, security, and portability of these pens make them a very useful adjunct. Foxes have bred and reared young in temporary pens that were only 12 by 15 feet, but such narrow quarters are not recommended for permanent use.

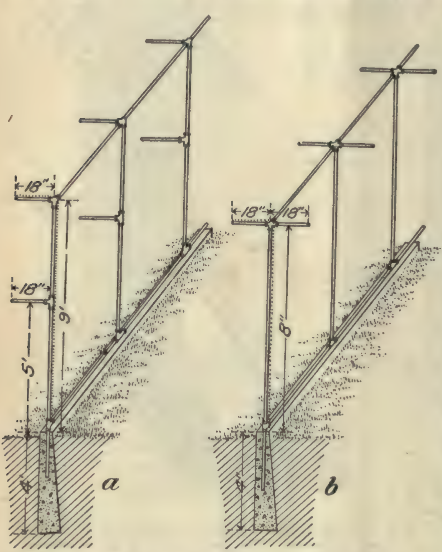


FIG. 16.—Iron posts and concrete foundations for yard fence, *a*, and guard fence, *b*. Note the 18-inch overhangs, two on the yard fence, one of which (5 feet from the ground) is to prevent foxes from climbing to the top and the resulting injury from the greater fall.

When alleys are used between pens, as shown in figure 14, it is well to have them closed at the outer ends to facilitate the return of escaped animals and provided with overhangs. Entrance to the yards should be by way of these alleys.

Doors may be made entirely of wood, or of netting attached to a durable frame which can not be gnawed by a fox or warped (fig. 19). If they are divided into upper and lower sections of equal size, much of the labor of clearing paths when snow is deep can be eliminated by leaving the lower half of each door closed.

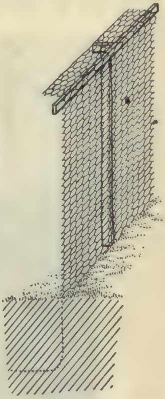


Fig. 17.—Fence extending into the ground.

GUARD FENCES.

The guard fence surrounding a fox ranch is generally constructed like the yard fences already described. Where snow drifts badly the fence should be built of boards rather than netting, in order to keep the snow from piling up in the yards. In addition to the usual inward overhang, it should have an outward overhang of barbed wire to keep out dogs and other intruders (fig. 15).

FOOD.

The natural food habits of foxes are similar to those of dogs. Birds, mice, rabbits, and other animals are eaten, as well as grasshoppers, crickets, and other insects, eggs, and many kinds of berries. In short, the animals are practically omnivorous.

The rations of domesticated foxes include beef, horse meat, mutton, veal, woodchucks, rabbits, liver, fish, eggs, milk, bread, mashed potatoes, crackers, mush, dog biscuit, boiled turnips and carrots, and fresh fruits. The selection of meats is largely a matter of circumstances. At irregular and uncertain intervals one may obtain injured or worn-out but otherwise healthy horses, or old sheep that can not be fattened for mutton, and these, when slaughtered, make good and cheap meat. Woodchucks and rabbits, freshly killed, are always welcome in a fox yard. When cheap meats fail, beef and poultry are used.

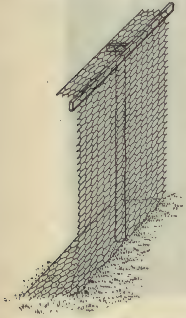


Fig. 18.—Fence turned inward at surface of ground to form a mat.

Fortunately, foxes do not need meat every day. Some keepers feed it but two or three times a week. Young foxes are not allowed meat until they are four months old, as it is likely to cause rickets. Meat intended for a brood vixen may be fastened to the top of a table out of the reach of her cubs.

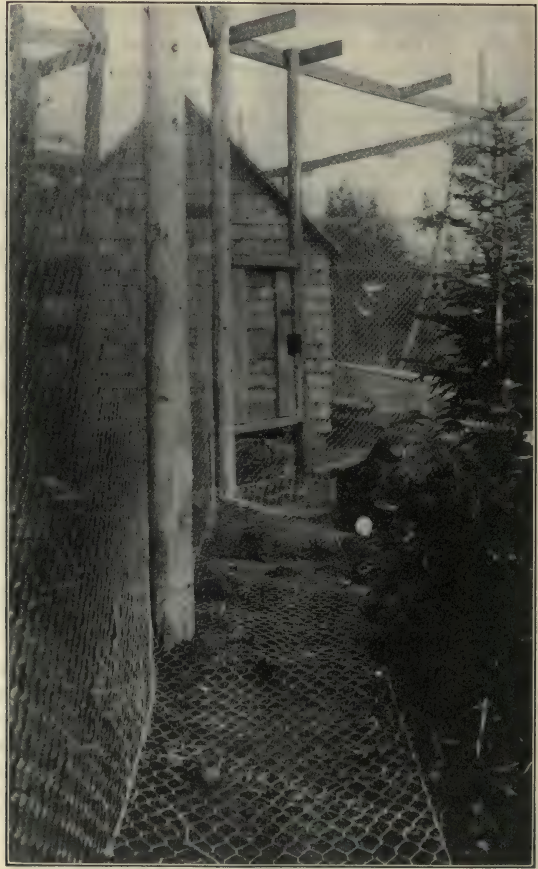


FIG. 19.—Details of entrance, mat, and overhang of a fox yard.

Milk, with some sort of bread or cooked mush, is the standard food for old and young. Foxes, which are fed twice a day, usually have meat in the morning and bread or mush and milk at night. In summer the proportion of meat is less than in winter. When smelts or trout can be had they are frequently substituted, but fish is not considered good for foxes in warm weather. Coarser fishes are sometimes used, but are not very much in favor. It is not deemed well to feed milk and fish on the same day. Milk and eggs are often given to females about the time cubs are expected, to strengthen them, relax their bowels, and allay fever. Fish, liver, and tripe are other laxative foods which may be used instead of milk and eggs. A diet of eggs, milk, mush, and wheat bread without leaven or salt is excellent.

The preparation of food for foxes deserves careful attention. All dishes should be kept clean. Meat that is diseased, tainted, or infected with parasites must be boiled. It is better to skin rabbits, as their hair readily felts and sometimes forms in balls in the stomachs of animals which feed on them. Their heads and entrails also should be removed, as these parts are frequently infested with parasites. Smelts and small trout may be fed whole, but larger fish should be dressed and the backbones removed. Chilled meat should be warmed before being offered to cubs or nursing females. Oatmeal or cornmeal mush should be thoroughly cooked. All food for sick animals should be cooked to make it more digestible and to free it from disease germs.

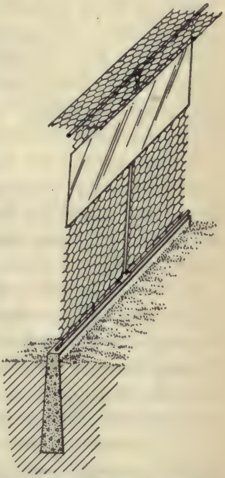


FIG. 20.—Section of a fence containing a smooth zone to protect foxes from injury from falling. Concrete foundation and iron posts.

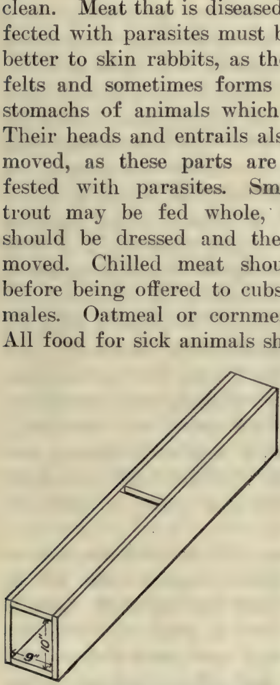


FIG. 21.—Chute for connecting yards. It can be closed by inserting a sliding door in a slot.

Foxes should be fed regularly twice a day, morning and evening. This is especially important in hot weather, as whatever is left from the first meal will spoil before time for the next. By giving at each feeding only the proper quantity the injurious effects of gorging can be avoided. Overfeeding is more dangerous than underfeeding.

Foxes that are to be slaughtered for their pelts are well fed during the autumn months, as the finest skins usually come from fat animals. Brood animals, on the other hand, are kept thin throughout the summer and up to about the first of January, when their rations are increased to prepare them for the breeding season.

PROPAGATION.

Foxes mate in February or March. The mating season is often revealed by a brownish discharge and may last anywhere from a few hours to two or three days. The gestation period is about 51 days. The size of litters ranges from one to nine, the average being about four. Each male remains faithful to the vixen of his choice and is an exemplary husband and father. During the first few days after the cubs are born the vixen remains in the den. Meanwhile her mate brings her food and remains constantly in the vicinity to apprise her by warning barks if an enemy approaches. Attempts have been made by fox breeders to mate one male with several females in the same season, but, as a rule, the results have not been encouraging.

Males are removed from the breeding yards for a part of each year, the length of their exile depending upon the relations of the pair. If they are quarrelsome, it is best to separate them soon after the female becomes pregnant. If, on the contrary, they agree and show attachment to each other, it is wise to keep them together until the cubs are four weeks old, but after that the male is likely to bite them during scrambles for food at meal times. While sequestered, the males are usually kept in small pens which may adjoin the breeding yards, as shown in figures 13 and 14, or removed to a separate inclosure, where they may be allowed to run together in a large yard or confined in individual pens. Because of their inclination to fight, individual pens are preferable.

The reproductive period in foxes is about 10 years. Approximately 50 per cent of the females in domestication breed each year, and the aggregate increase is not far from 100 per cent for the total stock on ranches. Failure to breed is attributable to a variety of causes, among which are sterility, injuries, worry, and mismating. Females barren for two years in succession frequently become productive on being mated to a different male. Prolific vixens, run down by several litters in succession, sometimes skip a year in which to recuperate.

The excitable disposition of foxes is one of their most troublesome characteristics, and no opportunity should be lost to abate it. In the breeding season it is very essential that nothing shall occur to make them apprehensive. A nervous vixen is likely to refuse the attentions of her mate, or to injure herself and cause abortion, or, what is still more probable, to destroy her young soon after they are born, by neglect, or by taking them from the warm den and carrying them about the yard in search of another hiding place. In her extreme anxiety she looses all her instinctive prudence. She becomes essentially insane, and only the closest attention on the part of her keeper can save her cubs.

From the time the cubs are born until they are two or three weeks old constant care must be taken to prevent losses in this manner. Any unusual sight, sound, or odor, by day or night, is liable to alarm a vixen and cause her to maltreat her young. The best way of dealing with a worried vixen is to shut her with her cubs in the den for several hours or until she becomes pacified. If she is disturbed by the proximity of other foxes, as sometimes happens, her view should be limited by boarding in the lower 2 or 3 feet of her yard.

CARE OF YOUNG.

Young foxes are subject to other troubles which, unless corrected, often prove fatal. They may be infested with external or internal parasites, or their mothers may not have enough milk to nourish them properly. It is very important that their condition from day to day be known. But the great value of the cubs and their danger from the irritability of their mothers generally cause the keeper to refrain from looking into the dens. By watching the behavior of the mothers they judge whether the young are doing well. It has been demonstrated by at least one progressive keeper that this uncertainty is by no means necessary. Foxes are not excited by routine events. By giving them large two-room dens, similar to the one shown in figure 9, and always feeding them in the outer compartment, they are led to expect the entrance of the keeper as the regular preliminary to each meal, and even to welcome it. When the keeper enters, they, of course, depart, leaving him free to look into the inner den. He should not touch the cubs unless they need attention.

The young are small and weak at first, and their mother remains with them almost constantly for the first three days. They grow rapidly and usually begin to appear outside the den in about a month. When 6 weeks old they eat more or less solid food. After this they may be weaned. Many breeders leave the weaning entirely to the vixen unless she is becoming emaciated. A decided advantage in weaning cubs when they are 6 or 8 weeks old is that when the keeper controls their food he can more easily eradicate the intestinal worms which usually infest them. Care should be taken to keep early-weaned cubs clean and dry. In case of accident to a mother fox, cubs may be reared by cats almost from birth. Not more than two cubs should be given to one cat. After they are about 3 weeks old their teeth become large and sharp enough to lacerate their foster mothers, and they must be reared by hand.

The taming and training of the foxes when pups tends to the production of adult animals which are much more valuable for breeding purposes. That attempts to tame pups may meet with some degree of success is well shown in the illustration on the title page.

BEHAVIOR.

During the day, particularly in fine weather, foxes are generally quiet, staying either in their dens or curled up among the branches of a tree or upon a shady platform several feet above the ground, whence they can see all that goes on around them. Late in the afternoon they arouse and until morning engage in a variety of activities. Sometimes they run and caper joyfully; sometimes when the soil is soft and the yards are not floored they dig, although animals accustomed to captivity rarely show a determined effort to escape by this means. When suddenly frightened they often attempt to escape by climbing the fence.

In the majority of fox yards the inmates skulk and hide whenever anyone approaches, although ordinary travel along a thoroughfare a hundred yards or more away gives them no apparent concern. All moving objects interest them keenly. Birds alighting within their yards often fall prey to their agility. Among themselves they are generally at peace, but a flash of treachery is likely to be displayed whenever one animal finds another at a disadvantage. One fox will seize and mangle another's foot that has been carelessly placed on the intervening fence, or will maim or kill a neighbor's cubs.

The natural timidity of foxes can be largely dissipated by special efforts to domesticate them in the full sense of the word. By weaning them early and thereafter feeding them from the hand, they usually become gentle and attached to their pens. When animals escape they sometimes return of their own accord or allow their keepers to capture them without difficulty. For example, a tame red fox after being liberated from a ranch maintained for cross and silver foxes went to live in the woods but presented himself early each morning at the gate of the ranch to be let in for a visit with his former comrades. After a time he commenced a burrow on a dry knoll in one corner of the outer yard and devoted half an hour daily to its extension. Although his career was, unfortunately, cut short by a trapper, he lived long enough to indicate very clearly that the wildness of foxes can be modified or even overcome.

HANDLING FOXES.

Unless foxes are diseased or injured, it is rarely necessary to lay hands on them. When one is to be removed from its yard, ordinarily it can be first driven into its den and thence into a small handling box having a sliding door at one end and strong wire netting covering one side. In this manner it can be transferred without danger of injury to itself or its keeper. It is best to darken the handling box by covering it or by turning the netted side downward on the ground before attempting to drive a fox into it. In actually handling grown foxes it is prudent to wear gloves to guard against being bitten, though this precaution is not always adopted by experienced keepers. An effective device for catching foxes is a pair of tongs with jaws curved to form a circle 2½ inches in diameter. The fox is first driven into its den or into a large covered box. Then the cover is raised barely enough to let the tongs pass in and grasp the fox around the neck. By holding the tongs in one hand and grasping the hind feet and tail of the fox with the other, the animal can be held securely.

Healthy foxes if properly boxed and cared for can be shipped safely almost any distance. Two foxes, or even more than two, are sometimes shipped in the same compartment, but this is inadvisable unless the distance is short. As a rule, a box containing two should be partitioned, each animal having a space equivalent to 2 by 3 feet on the floor and 1½ feet high. About half of one side of the box should be removed and the opening covered with wire netting to allow ventilation and inspection. Shippers often cover the entire box with netting or tin to preclude the possibility of escape. A dish for water should be fastened to the floor close to the front, where it can easily be filled. Foxes are not usually injured by a fast of three or four days, but they should not be allowed to suffer from thirst. Express companies, if duly instructed, will feed animals en route and add the cost to the regular transportation charge. In case the animals are very valuable or are to be shipped a long distance, an attendant should accompany them.

HEALTH.

Generally speaking, sickness is not common among domesticated foxes that are well cared for. Once in a while one breaks a leg as the result of a fall or, more often, from entanglement in wire netting having too coarse meshes. Lacerations rarely result twice from the same cause or from fighting. Even more rarely is a fox choked while eating. Passing meat and small or soft bones and cartilage through a bone grinder will not only prevent choking, but allow enough bone to be fed with the meat to produce sturdy animals. Simple fractures, uncomplicated by abrasions, will mend if untouched, but it is better to bind splints upon the wounded limb to keep it in proper shape, and then to apply iodoform to prevent the animal from tearing them off. When a bone is badly shattered, and especially when it protrudes, the leg should be amputated. Anesthetics are likely to kill foxes and hence should not be used. Flesh wounds ordinarily require no attention other than washing once or twice a day in warm carbolated water or with Castile soap, followed by an application of hydrogen peroxide.

Thus far no widespread disease among foxes has made its appearance. When diseases occur they mainly affect the digestive organs, and usually can be traced to improper feeding. Indigestion and inflammation of the bowels are not uncommon among cubs. Isolation in clean, dry quarters is the first step toward a cure, and rest and fasting are better than medicine. A spoonful of milk diluted with six spoonfuls of boiled water will quench thirst and aid in maintaining strength. The feces should be examined daily. Constipation is frequent, and it is especially dangerous to vixens during the first three days after the birth of their cubs. It can generally be corrected by a laxative diet, as milk, liver, or veal, but in extreme cases a dose of castor oil or an injection of soapsuds may be necessary. A protracted attack of diarrhea can usually be checked by a purge of castor oil followed by small doses of laudanum. Generally, however, a day or two of fasting followed by short rations of cooked milk or milk and eggs, at intervals of two or three hours, will effect a cure. During such an attack vitality runs low, and care must be taken to keep the afflicted animal in a warm, dry place. It should have access to water that has been boiled. Growing cubs are frequently subject to weakened and distorted legs. This disease, known as rickets, can be prevented by including ground bone in their meat rations and by adding limewater to their milk. The bones of calves and those from the briskets of beeves are comparatively easy to crush so that foxes can swallow them.

At quarantine stations where imported animals are examined, particular attention is directed to symptoms of rabies and mange. The fact that rabies, or hydrophobia, is communicable to man makes it doubly dreaded. Fortunately it has not appeared among domesticated foxes so far as known. Mange is characterized by a loss of fur. It is caused by a tiny parasite, somewhat like the itch mite, and is, therefore, very contagious. Were it to obtain a foothold among domesticated foxes, it would seriously hamper and perhaps ruin this branch of the fur industry. All animals showing a tendency to have bare spots should be isolated at once. The diseased parts should be treated daily with ointments, as petrolatum or a mixture of lard and sulphur.

Foxes serve as hosts for a number of other parasites. Lice and fleas infest their hair and skin, while roundworms and tapeworms drain their vitality from within. The death of a fox has occasionally been attributed to lice. Even if not fatal, lice and fleas diminish the vigor of their hosts and should be persistently combated. Some fox breeders dip all their animals in a nonpoisonous bath such as is commonly used for dipping sheep. It is well in any case to dust the dens with sulphur and insect powder at frequent intervals.

The intestinal worms infesting foxes are difficult to eradicate. Probably more young foxes succumb to the effects of roundworms than to any other cause. These worms are whitish and cylindrical, tapering toward either extremity. Among the symptoms indicating their presence are dullness, barking, frothing at the mouth, dragging the body by the forelegs, and convulsions. The flat, jointed tapeworm, often a foot or more in length, is a less fatal as well as a less common internal parasite, but animals suffering from them are emaciated and lack overfur or guard hairs. As a cure for worms one breeder of long experience frequently gives his cubs a meal of crushed flaxseed and milk, alternating now and then with six or eight drops of spirits of turpentine in milk. Another doses his cubs every fortnight after they are four weeks old with a proprietary vermifuge put up in gelatine capsules for puppies and pet dogs, beginning with half the contents of one capsule. Castor oil containing a few drops of turpentine is also recommended. Any remedy administered by hand must be pushed down below the base of the tongue, when it will be involuntarily swallowed.

A fox sometimes dies from no assignable cause. More often fatalities can be traced to a lack of care or foresight. The dishes from which the animals eat and drink should be washed daily and scalded frequently. The water should be clean and changed daily. The food should be varied and wholesome. Danger from unwholesome food is well illustrated in the experience of one ranchman who lost several of his choice breeders through feeding them spoiled fish; and another who lost $100,000 worth of cubs as a result of thoughtlessly exposing meat overnight to the fumes of gasoline in his slaughterhouse. The appearance of each animal should be critically noted every day. On many of the larger ranches a doctor is regularly employed to look after the health of the stock. In the care of foxes an ounce of prevention is worth a pound of cure.

IMPROVED STRAINS.

The fact that domestic animals originated from wild stock and that improved strains have from time to time been secured makes it reasonable to assume that other wild animals can be differentiated and improved by the same method, namely, selective breeding. So far as foxes are concerned, this has already been done. The pioneer fox breeders began with ordinary silvers, which have a tendency to produce red as well as silver progeny. At that time dark pelts were more valuable than light-colored ones. By regularly disposing of the less desirable cubs and breeding only from the best, the tendency to throw red was soon eliminated and the color of the fur greatly improved. Within 16 years from the time the two pioneer fox breeders built their ranch they were sending to market the finest fox pelts in the world.

The tendency of wild silvers to produce red progeny is accounted for by the fact that owing to their scarcity probably only one in a hundred can have a silver mate; perhaps three in a hundred may mate with cross foxes, which are merely hybrids, or descendants from hybrids, between silvers and reds; and the remaining ninety-six must mate with reds. In any event, although some of the cubs may be silver, all of them will inherit from their red ancestors a tendency to throw red. As has already been pointed out, however, this tendency very soon disappears under the influence of careful breeding. Generally speaking, pure strains of silver foxes breed true. So also do pure strains of red. When a red and silver are mated together, the color of the progeny can not be foretold. The cubs may be red with black throats, or they may be crosses, or a mixture of the two. One or more may be silver, but this is unusual. Random breeding from silvers and crosses of unknown pedigree is equally uncertain, as is shown by the following results:

A silver mated with a red produced two crosses, which when mated together produced one red and four silvers. A silver and a cross produced three silvers and two reds. A cross and a red produced two crosses and two reds. A cross and a cross produced two silvers, two crosses, and one red. Another pair of crosses produced nine crosses. A red of silver-cross parentage mated with a red of silver parentage produced one silver and two crosses. A silver and a red produced in two successive years thirteen silvers. A pair of reds from the same litter as two silvers produced three silvers, one cross, and two reds. A pair of silvers produced one silver and five reds, two of which, when mated together, produced three silvers and one red the first year and two silvers the next year. Another pair of silvers produced four crosses, while a silver and a cross produced a litter of all silvers.

These results indicate the uncertainty of breeding at random, but they show also that if a fox of any color whatever has a silver strain, the silver can be made to appear in succeeding generations by selective breeding. This fact is most important. Suppose a breeder has a strain of silvers lacking in size, or fecundity, or in some other desirable particular. He can introduce specimens having the desired qualities without having to consider color. A red fox can be used if one of better color is not available. In the course of three or four generations the silver can be fully reinstated. Among the features to be considered besides color are size, fineness of fur, fecundity, docility, and hardiness. Fecundity appears to be a hereditary trait among foxes, daughters of prolific mothers being themselves generally prolific. How rapidly other desirable characters can be incorporated remains to be determined. As with poultry, horses, and other farm animals, so it is with foxes. Each breeder should strive to perfect his animals according to some standard. Eventually there may be several standards based upon varied uses or requirements.

The process of developing improved strains can undoubtedly be shortened by taking advantage of local variations in foxes. One of the lines of investigation conducted by the Biological Survey includes the geographic variations of North American mammals, and from this it is possible to say not only where silvers and crosses occur most frequently, but where the largest and the best-furred foxes are found. Upward of 20 species or subspecies of red foxes have been named in the United States and Canada. The medium-sized foxes along the North Atlantic coast are notable for their fine silky hair. The largest foxes are in Alaska and on the Plains northward from Minnesota and North Dakota. The large size of Alaskan coast foxes is offset by long, coarse pelage, which is decidedly longer on the shoulders and back of the neck than on the back and hips. It remains to be seen whether in crossing them with the smaller, finer-haired animals the progeny will be large or small, coarse-haired or fine, or intermediates. There can be little doubt, however, that in the long run such a cross will result in larger fine-haired foxes than any now existing. The northern part of the red fox's range has, as a rule, a larger proportion of silvers than has the southern. An exception is found in the Cascade Mountains in Washington, Oregon, and California, where, judging from specimens in the National Museum, the percentage of melanistic specimens is very large. They have little to recommend them besides color, however, as they are small and have rather coarse fur.

Black and silver foxes are found in North America practically throughout the range of the red fox. The best-furred animals do not occur, however, throughout this range, but are obtained mainly in restricted areas. For instance, skins from the Tanana River district in Alaska and the adjacent part of Yukon Territory, from certain other parts of northern Canada, and from the North Atlantic coast from Maine to Labrador, including Prince Edward and other islands, are of about the same grade. This is recognized by the leading London furriers, who report that "in our opinion fox skins from Labrador, Newfoundland, or Alaska are equal in quality to those from Prince Edward Island."

It is not known that any particular geographic race of foxes is especially characterized by fecundity or docility. These qualities are probably individual, occurring in about the same proportion everywhere, and while of secondary importance, in the long run they are sure to be favorable to success in fox farming. Already prolific pairs bring much higher prices than those which have thrown small litters or have not been tested. Inasmuch as one of the main causes of loss among young cubs is the timidity and nervousness of vixens, the development of more docile strains will result in corresponding increase in the birth rate. Some male foxes are much better mates and sires than others. In selecting breeders the temperament of males as well as of vixens should be considered. The physical development and potency of males are also essential factors. Young males that are not strong or not well developed when six months old are not likely to be of use in the breeding yards the first year and should not be selected for sires.

Food is recognized as a very important element in the development of good animals. The finest specimens of domestic cattle are those which have been fed most wisely. As regards foxes, much remains to be learned concerning the effects of different rations upon such matters as fecundity, character of fur, and rate and limits of growth. It should be a part of every breeder's plan to discover all he can about the relative values of foods and methods of handling, as influencing the process of selective breeding. Ultimate success or failure in fox farming depends largely upon the aspirations of those engaged in it. If breeders earnestly, consistently, and indefatigably endeavor to improve their stock and to produce pelts that are larger, softer, and more uniformly colored than the usual run, there can be no question as to the result. There will never come a time when an extra fine silver fox pelt will not command a good price nor when a breed producing such pelts will not be in demand.

ACCESSORIES.

Contentment and vigor of the animals within a ranch is of the utmost importance. Whatever contributes toward increasing these qualities should be incorporated if possible. It is well to test young foxes with such toys as a ball, a tin can, or a piece of woolen cloth, with a view to amusing them and exciting a spirit of playfulness. A variety of objects in which they can hide and upon which they can mount for a survey of their surroundings, as hollow logs, stumps, brush piles, or open barrels, is desirable.

While the suggestions given under this heading apply primarily to persons having large capital invested in fox farming, they will also be found helpful to those operating on a small scale. The present value of silver foxes is so great that every precaution is taken to prevent accidents, sickness, or other misfortunes. Watchmen are kept on guard day and night. The keeper's lodge is just outside the guard fence. In addition there is sometimes a tower, from the top of which a view can be had of all the yards. Here are recorded the progress of events in the breeding season; and from here quarrels, accidents, or signs of sickness can be discovered without alarming the animals.

A tower 12 or 15 feet square and three stories high, fitted up as a 3-room house, would contain on the top floor the watchman's couch, chair, and field glasses, his table and writing materials; a cook stove, pantry, sink, and other kitchen appurtenances will be on the ground floor, and here food for the foxes can be conveniently prepared. Somewhere about the place there will be a medicine chest and various tools likely to be needed in an emergency.

Risk of loss by theft or escape is lessened by installing electric lights which can be turned on at any time, and an electric burglar alarm. Bulldogs are used to reenforce the night watchman; and on some ranches bloodhounds are kept for tracking thieves. Foxes that escape generally return to the vicinity of the ranch when hungry, and a number of small steel traps having the jaws wound with cloth should be kept on hand to catch them. Ranch foxes have less endurance than wild ones, and a good hound can usually overtake one after a short run. The manager of a ranch on Prince Edward Island has a hound which on several occasions has assisted in the capture of foxes without hurting them in the least. Such dogs are excellent insurance against loss by escape.

Other accessories of a fox ranch, and those most prominent, pertain to food supplies. There must be facilities for slaughtering horses, cattle, and smaller animals; an ice house and a refrigerator for keeping the meat fresh until it can be used; and conveniences for drying, smoking, and salting meat that must be kept a long time. A screened room or box is necessary to protect stored meat from flies. Cows are needed to furnish milk, an important element in the diet of domestic foxes. In a dairy region calves are disposed of when but 2 or 3 days old. At that age they are small, and their flesh is soft. Sometimes there are more calves on hand than can be used immediately. By having cows to suckle them a few weeks, the veal, improved in quality and increased in quantity, will be available when needed. Rabbits are the natural prey of wild foxes. They have an important place on a fox ranch as a fox food which can be drawn upon at any time, which is always fresh, and which is in such small units that ice or other preservatives are unnecessary.

Occasionally a vixen having young cubs is unable to give them proper attention. Then a foster parent must be supplied at once or the cubs will die. To provide for emergencies of this kind, every ranch should include several female cats.

MARKETING.

The products of a fox farm—breeding stock and pelts—are ready for market at definite seasons. The live animals are mainly sold during the autumn, as it is to the interest of buyers to have their stock fully accustomed to new surroundings before the breeding season. By the middle of September young foxes are large enough and the weather is sufficiently cool for shipping with safety. When there is not an adequate local demand, foxes are generally disposed of by advertising in publications devoted to furs, fur farming, or trapping. Shipments of live stock by express are generally at the risk and expense of the purchaser. Valuable animals are usually accompanied by a caretaker, especially if the journey lasts more than two days.

Skins of foxes killed late in December, when fox fur is in its finest condition, are ready for market in January. Foxes are skinned by making a cut straight from one heel along the rear edges of the hind legs and beneath the tail to the other heel, and withdrawing the body through this slit. The skin of the tail should be cut along the lower side, its entire length, and the bone removed in order that air may come freely into contact with the flesh side and dry it quickly. Unless this precaution is taken, the tip of the tail is likely to decompose and lose its hair. For the same reason the back skin of the ears should be separated from the cartilage to which it is attached. When the operation of skinning is over, the pelt is freed from particles of fat and muscle. It is then drawn, flesh side out, over a stretching board similar to the one shown in figure 22, not for the purpose of actually stretching the skin but to prevent it from shrinking and becoming wrinkled as it hardens. Before the skin is completely dry it should be removed from the board, turned hair side out, and hung by the nose where it will be free from pressure on all sides. No preservative is required. Although raw fur buyers are to be found in nearly every town in fur-producing regions, fox farmers prefer to sell their peltries direct to metropolitan establishments, where rare furs are handled extensively and where experienced furriers are familiar with values.

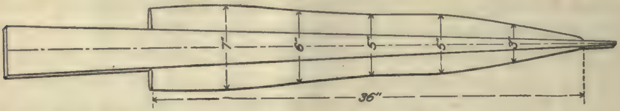


FIG. 22.—Diagram for stretching board for casing skins. The wedge makes it adjustable in width and facilitates removal from a skin.

In preparing valuable peltries for market, extreme care should be taken to prevent blood from coming in contact with the fur. With this in view, the method of killing commonly adopted is to lay the fox on its side on clean snow, and then to compress its chest by standing upon it. This stops the action of the heart and lungs and death follows immediately. The same result, without the unpleasant features connected with thus catching and smothering the animal, can be obtained by means of a killing box, which from a humanitarian point of view is preferable. This is merely a tight wooden box into which the fox is to be driven from its den. When the fox is inside and the door securely closed, an ounce or two of chloroform or carbon bisulphide is poured through a hole in one of the upper corners into a wide, shallow dish, as a tin pie plate, fixed just below in such manner that the fox can neither get into it nor upset it. The hole through which the pouring is done should be corked at once and every part of the box made practically air-tight. The smaller and tighter the compartment the less will be the quantity of anesthetic required. The box should not be opened within half an hour.

In localities where fox farming is carried on extensively, it will be found advantageous for producers to establish a selling agency in charge of one familiar with the fur trade. In this way it will be possible to match many of the skins and sell them in sets at a higher price than can be obtained for odd skins.

COSTS.

The cost of establishing a fox ranch varies according to the materials used, transportation facilities, and the proportion of labor performed by the owner. The factory price of the netting described in the section relating to inclosures is from 1 to 3 cents a square foot, according to the mesh and size of wire, when sold in rolls containing 150 linear feet. It is manufactured in the various widths required for different parts of the fences. Ordinarily in a fur country the expense for lumber would not be great. A considerable saving can sometimes be made by building the guard fence of boards instead of netting. The average life of the netting is about 12 years, except when exposed to sea air, in which case it is only about 8 or 10 years.

Feeding a fox costs from $5 to $15 a year. On a farm where there are cows and where grain and vegetables can be raised, it is not necessary to buy very much fox food. Except on large ranches devoted exclusively to fox raising and where a special keeper must be employed, the care of a few foxes will not entail much outlay.

The fixed annual charges against a pair of silver foxes will vary with the locality, value of equipment, etc. On some ranches it has been estimated about as follows: Interest on cost of yards, $10; depreciation of yards, $10; food, $20; and attendance, $50; amounting to $90; added to this must be a reasonable charge for interest on the original cost of the pair. Killing foxes at the age of 4 or 5 years, when their pelts are good, and breeding always from young stock may be practicable, but this point has not yet been decided. As a rule, one may expect to keep choice animals as long as they are productive; that is, about 10 years. Deterioration, therefore, on the live stock will be 10 per cent; and to this should be added 10 per cent for insurance against loss by death, escape, or theft.

The value of breeding stock has fluctuated greatly in the past. In general, it will depend on the current demand for silver fox skins; and, in particular, on the character of the fur of individual animals. Prolific animals belonging to choice strains, in which a superior color and quality of fur have been fixed, are worth for breeding purposes as much more than ordinary stock as pure-bred horses are than common horses.

As has been pointed out under the subject of improved strains, crosses and reds derived from silvers throw a proportion of silver cubs. It is feasible, therefore, if one is willing to sacrifice the time required, to obtain a stock of silvers from these more common foxes, which cost comparatively little.

INCOME.

The profits from silver fox farming have generally been large. Prior to 1910 they were derived almost wholly from pelts, but since then they have come mainly from the sale of breeding stock. Following the decline of the speculative phase of the fox industry, ranch-raised silver fox pelts reappeared at fur sales, and brought encouraging prices, a few going as high as $1,000 each. January quotations for first-grade skins during the 12 years from 1905 to 1916 average about $600 each. Out of a miscellaneous collection of silver fox skins, principally wild, disposed of at auction early in 1916, 60 were sold at an average of $550. Many wild skins are necessarily imperfect, being unprime, worn, or not well colored, but those from selected domestic animals killed when their fur is at its best may be confidently expected to rank as first-class goods.

The supply of silver fox pelts must always come from cold climates beyond the more thickly settled temperate regions. They are not likely, therefore, to become overabundant. Red fox skins have been marketed for many years. Their numbers, while fluctuating considerably from year to year, on the whole have remained approximately constant. Their average value, however, has increased. But the supply from wild foxes can never be greater than it is now. Already red foxes can be raised and their pelts sold without loss, and it may be probable that before many years the rise in fur values and the introduction of more economical methods of ranching will result in making the raising of red foxes profitable. The silvers are of superior beauty and many years must pass before they can become common.

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SOME COMMON EDIBLE AND POISONOUS MUSHROOMS

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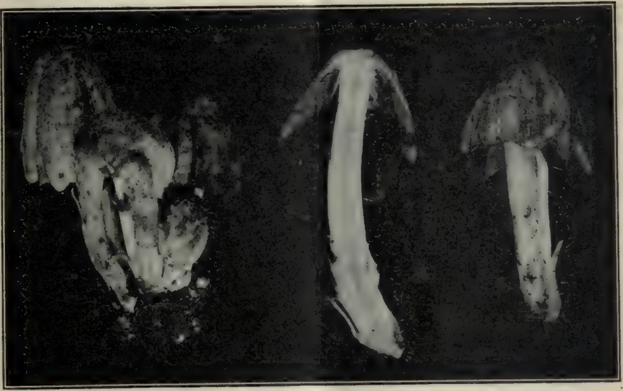

FARMERS' BULLETIN 796
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. March, 1917

EXAMINE CAREFULLY BEFORE YOU EAT.

MUSHROOMS and some other fungous growths are highly prized as articles of food by many people. The nutritive value of mushrooms is not high, but they may be prepared in various ways which will render them delicious. More people doubtless would seek wild mushrooms and other fungi if they were sufficiently informed to distinguish between the edible and the deadly poisonous growths. To assist the novice to make these distinctions is the purpose of this bulletin. Some very erratic and dangerous ideas concerning ways of telling the edible from the poisonous growths are altogether too commonly believed. Mushrooms are frequently thought of as edible and toadstools as poisonous. As a matter of fact, the words "mushroom" and "toadstool" are used indiscriminately and do not indicate whether the plants are edible or poisonous.

A test for poisonous mushrooms often recommended is based on the belief that if a silver coin placed in the utensil in which mushrooms are cooked tarnishes the mushrooms are poisonous. Absolutely no reliance can be placed on this test, as both poisonous and edible kinds may turn silver dark.

Equally baseless is the belief that a mushroom is shown to be edible if the skin can be peeled from the cap readily, because peeling is possible with many poisonous species.

The notion that soaking or boiling poisonous mushrooms in salt water will render them harmless has no foundation in fact.

Some people have thought that the presence of insects on mushrooms is a proof of their edibility. This is a dangerous supposition, because insects infest the most poisonous as well as the best edible species of fungi.

The collector of mushrooms can not depend upon any simple test. If he intends to use them for food he must know what he is gathering. It is a comparatively simple matter to learn to recognize a few kinds of deadly mushrooms and certain edible ones. If he will gather only the kinds that are well known to him, a careful collector need not be afraid to gather wild fungi for food. He should not be misled by attractive colors or pleasant odors.

It is never safe to collect the young, unopened mushrooms, commonly called buttons, unless they are immediately connected by whitish threadlike strands with a well-known species, as even an experienced collector is unable to distinguish between poisonous and edible species when they are in the button stage.

In collecting and identifying mushrooms one must make a careful examination of the specimens while fresh, as mushrooms change very quickly after being gathered.

The species of fungous growths selected for description in the following pages are very widely distributed, and this bulletin should make them easily recognizable by a careful observer who wishes to become acquainted with some of the varieties commonly found in gardens, lawns, woods, and pastures.

Recipes for cooking will be found on pages 19 to 23.

SOME COMMON EDIBLE AND POISONOUS MUSHROOMS.

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THE STRUCTURE OF MUSHROOMS.

The parts which are common to all mushrooms are the cap and the stem. Some species may have a volva or a veil, or both. The volva is a membranous envelope or sac, which in the young state completely surrounds the plant. (Fig. 1, *A*, *e*.) Underneath the cap are plate-

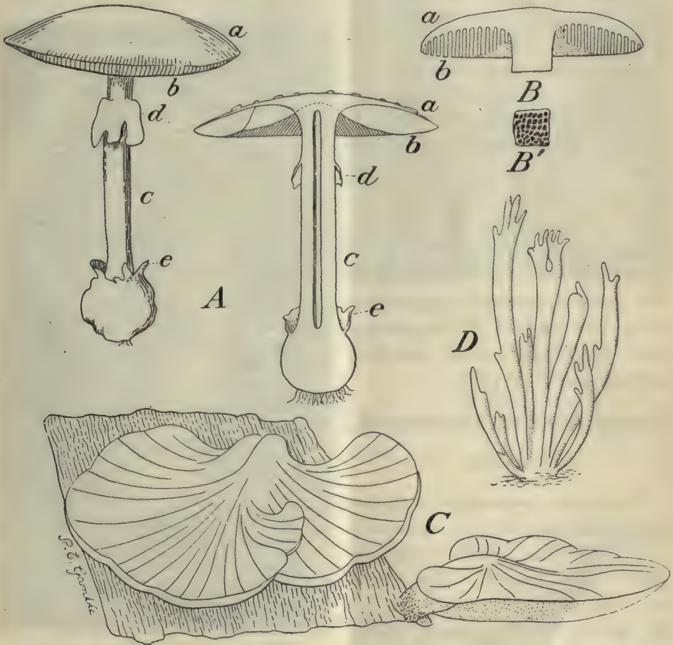

FIG. 1.—*A*, A gill-bearing mushroom (side view and vertical section): *a*, Pileus, or cap; *b*, gills; *c*, stem; *d*, ring; *e*, volva, or cup. *B*, A tube-bearing or pore-bearing mushroom (section of upper part); *a*, Cap; *b*, tubes, or pores. *B′*, View of part of the lower side of the cap of a tube-bearing mushroom. *C*, A beefsteak fungus. *D*, A coral fungus.

like folds, called gills. (Fig. 1, *A*, *b*.) In some mushrooms the gills are at first covered with a thin veil, which as the plant develops may entirely disappear or remain as a ring (fig. 1, *A*, *d*) about the stem.

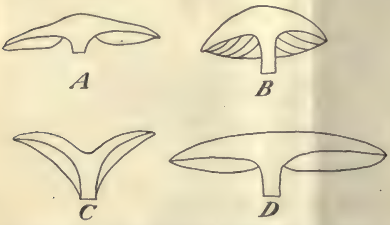

FIG. 2.—Mushrooms showing varying shapes of caps and kinds of gills: *A*, Cap umbonate, gills free; *B*, cap convex; *C*, cap funnelform, gills decurrent; *D*, cap expanded.

The shape of the cap is a very important character in identifying mushrooms. The terms used in this bulletin to describe its shape are umbonate, convex, expanded, and funnelform. These words may be best understood by referring to figure 2.

Mushrooms are reproduced either by spores or by spawn. The spores, which are very minute bodies, are borne on the gills and may be seen as a fine powder when the mature mushrooms are shaken. The color of the gills depends upon the color of the spores, which may be white, yellowish, brown, pink, purplish, dark brown, or black. Mushrooms are also reproduced from spawn, which is a white, thread-like growth, generally appearing below the surface of the ground and frequently seen running through manure piles.

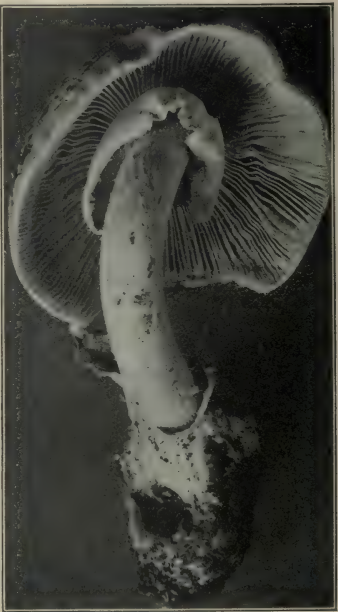

FIG. 3.—Death cup. (Poisonous.)

DESCRIPTIONS OF MUSHROOMS.

AMANITAS.

The most poisonous fungi belong to the genus[1] Amanita, and although this genus contains some edible species[2] the surest way to avoid danger is to let all species of this genus alone. A fungus of this kind may be recognized among the white-spored agarics (gill fungi) by the presence of a volva and a veil. Young plants are completely inclosed by the volva, and the manner in which it breaks away varies according to the species. A part of the volva remains on the top of the cap, around its margin as scales, or as a broken cup at the base of the stem.

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[1] Genus: A group of closely related species.

[2] Species: The smallest group of plants or animals to which distinctive and invariable characters can be assigned.

Death Cup. Amanita phalloides. (Poisonous.)

In the death cup (fig. 3) the color of the cap ranges from white or lemon or olive colored to brownish; it is fleshy, sticky when moist, and broadly bell shaped, or oval, with white gills. The base of the stem is large, forming a bulb which is in a large cup-shaped volva. There is a large white ring.

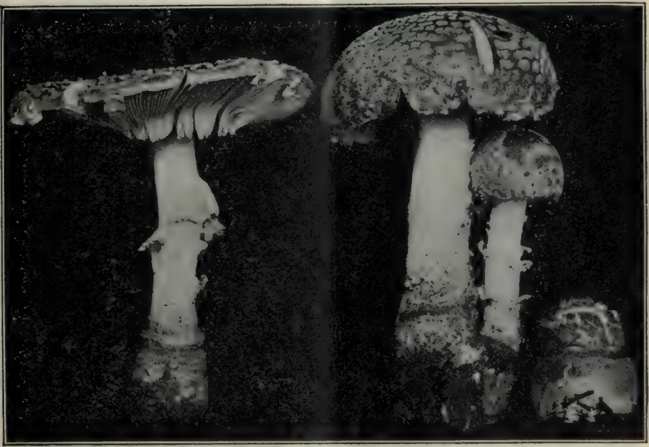

FIG. 4.—Fly agaric. (Poisonous.)

The death cup is the most dangerous of all mushrooms, and no antidote is known which will overcome its deadly effects. It is found growing in woods or on cultivated land from early spring until late summer.

Fly Agaric. Amanita muscaria. (Poisonous.)

In this species (fig. 4) the color of the cap ranges from yellow to orange or blood red and the remnants of the volva remain as whitish scales on the cap. The veil persists as a large, torn ring about the upper part of the stem, which is white and enlarged at the base and usually marked by scaly ridges or incomplete rings.

The fly agaric is very common and may be found from early summer until autumn.

PARASOL MUSHROOM. LEPIOTA PROCERA. (EDIBLE.)

In the parasol mushroom (fig. 5) the cap is at first ovate; later it becomes expanded, with a central elevation, and the cuticle (skin) breaks up into brown scales. The gills are free[1] and white. The stem is long and slender, with a large ring, which is movable when old.

This very attractive and graceful species is found in pastures, lawns, thin woods, etc. It appears singly or in small groups during the summer or early autumn.

GREEN-GILL LEPIOTA. LEPIOTA MORGANI. (POISONOUS.)

In the green-gill lepiota (fig. 6) the cap is fleshy, rounded, and white, with a yellowish or brownish cuticle (skin), which breaks up into scales except at the center. The gills are free, white, slowly becoming green. The stem is long, white, and has a large movable ring.

The green-gill lepiota occurs very commonly and abundantly, often forming large fairy rings. It is poisonous and should be strictly avoided. Even small pieces of the uncooked mushrooms have caused serious illness. The gills are slow in changing color, but they gradually become green, a characteristic peculiar to this species.

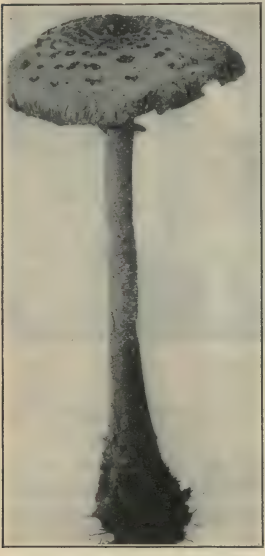

FIG. 5.—Parasol mushroom. (Edible.)

HONEY-COLORED MUSHROOM. ARMILLARIA MELLEA. (EDIBLE.)

The cap of the honey-colored mushroom (fig. 7) is oval to convex and expanded, sometimes having a slight elevation in the center, which generally has pointed dark-brown scales. Its color ranges from honey colored to dull reddish brown. The gills are white, attached to or running down the stem, which is spongy, smooth, or scaly. The ring is easily broken and often disappears.

The honey-colored mushroom is extremely variable in regard to the color, the character of the cap, whether smooth or scaly, and the shape and size of the stem. It is very common and is generally found at the base of rotting stumps, although it is often a serious parasite of fruit trees, causing root-rot.

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[1] Gills not attached to the stem are said to be free.

OYSTER MUSHROOM. PLEUROTUS OSTREATUS. (EDIBLE.)

In the oyster mushroom (fig. 8) the caps are shell shaped and have a very short lateral stem or no stem at all. The caps vary in color from cream white to brownish. The gills are white and run down the short stem.

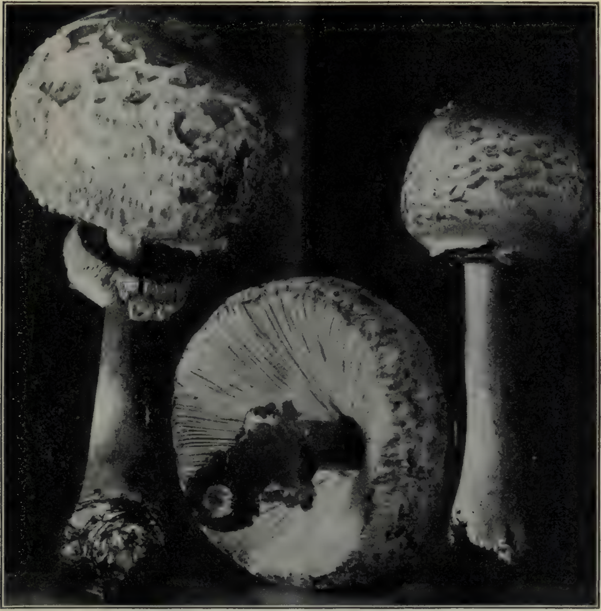

FIG. 6.—Green-gill fungus. (Poisonous.)

The oyster mushroom is a very fine edible species, occurring from spring until late fall singly or in clusters on the limbs or trunks of living or dead trees.

CHANTERELLE. CANTHARELLUS CIBARIUS. (EDIBLE.)

In the chanterelle (fig. 9) the cap is fleshy, thick, smooth, more or less funnel shaped, and with the margin often wavy. The color is very striking, being opaque egg yellow. The thick, veinlike, branching gills are of the same color as the cap and run down the stem, which is short and of the same color as the cap.

This species has long been considered one of the finest edible mushrooms and is especially prized in Europe. It is widely distributed and occurs in open woods and grassy places. It sometimes has an agreeable odor of apricots.

JACK-O'-LANTERN. CLITOCYBE ILLUDENS. (POISONOUS.)

The cap of the jack-o'-lantern (fig. 10) is fleshy, almost flat, finally funnel shaped, saffron yellow, becoming brownish in age. The gills are broad, running down the stem, and are the same color as the cap. The stem is solid, firm, rarely erect, generally curved, and of the same color as the cap and gills.

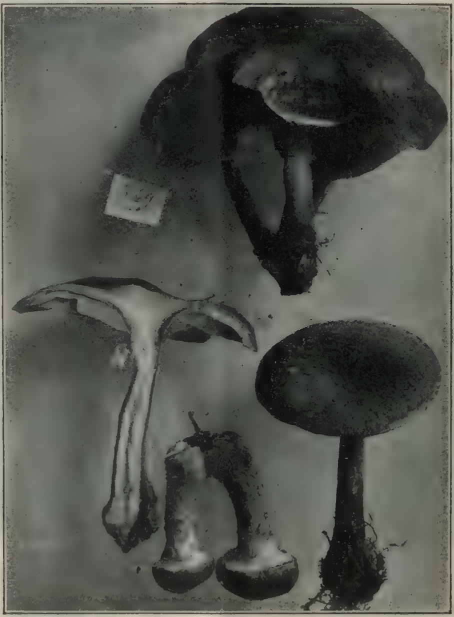

FIG. 7.—Honey-colored mushroom. (Edible.)

The jack-o'-lantern is a very conspicuous fungus, on account of its striking color and its habit of growing in large clumps about the base of decaying trees or stumps. Its common name was given it on account of the phosporescent character of the plants, which renders them visible at night. This species is not wholesome and should not be eaten.

EQUESTRIAN TRICHOLOMA. TRICHOLOMA EQUESTRE. (EDIBLE.)

In this mushroom (fig. 11) the cap is at first convex with inturned margin; later it becomes expanded. It is somewhat sticky and pale yellowish, with a greenish or brownish tinge. The gills are sulphur yellow and crowded, and the stem is short and stout and yellow in color.

This species is exceedingly good and is adapted to various methods of cooking. In many localities it appears abundantly in the fall under pine trees, often forcing its way through a dense mat of pine needles and forming irregular fairy rings.

LACTARIUS MUSHROOMS.

This genus is easily recognized by the white or colored milk, especially abundant in the gills. The plants are brittle and rigid, the stem stout and generally central. Some members of the genus Russula are similar to those of Lactarius in form and brittleness, but differ in the absence of milk. Many species of Russula are edible, but several are known to be poisonous. Although the red forms of Russula are especially attractive, it is safer not to eat them.

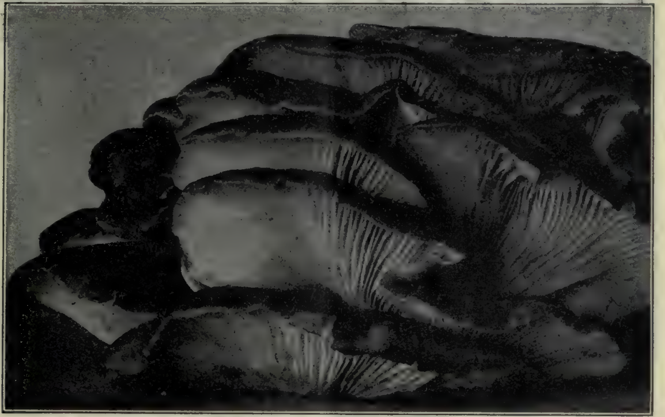

FIG. 8.—Oyster mushroom. (Edible.)

Indigo Lactarius. Lactarius indigo. (Edible.)

The cap of the indigo lactarius (fig. 12) is funnel shaped, indigo blue, with a silvery gray luster; in age it fades, becoming greenish. The gills are crowded, an indigo blue, and the stem is short and hollow.

This mushroom is easily recognized by its color.

Orange-milk Mushroom. Lactarius deliciosus. (Edible.)

In this mushroom the cap is convex when young; later it is depressed in the center and finally becomes funnel shaped. The cap is yellowish or deep orange and generally zoned.[1] The gills are yellowish orange, crowded, narrow, and often branched.

This mushroom may be distinguished by its orange color, its zones, and its saffron red and orange milk. A peculiarity of the plant is the fact that it turns green on being bruised. This species has always been highly appreciated for its edibility; it is widely distributed and abundant.

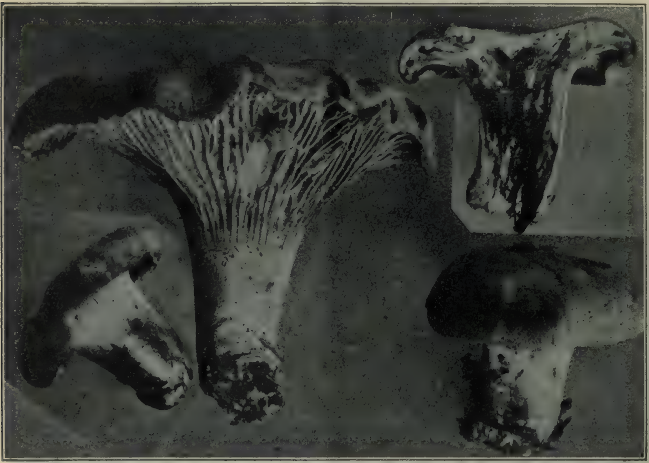

FIG. 9.—Chanterelle. (Edible.)

FAIRY-RING MUSHROOM. MARASMIUS OREADES. (EDIBLE.)

In the fairy-ring mushroom (fig. 13) the caps are convex (fig. 2), but later may become plane, with a slight central elevation. They are rather tough, smooth, cream colored or brownish buff. The gills are broad, not crowded, whitish or cream colored. The stem is tough, the upper part hairy, and the base smooth.

This is a very common edible species and frequently occurs in considerable abundance on lawns.

FAWN-COLORED PLUTEUS. PLUTEUS CERVINUS. (EDIBLE.)

The cap of this mushroom is at first bell shaped, but it later becomes convex and expanded to almost plane. It is light or grayish brown, usually smooth, but with darker fibers or hairs. The gills are broad, at first white, later becoming flesh colored or pink. The stem is the same color as the cap, and firm, smooth, or scaly.

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[1] Marked with circular bands of color.

This species belongs to the pink-spored group of mushrooms. It is found at the base of dead stumps, fallen logs, and sometimes on sawdust piles. When young it is edible and of good flavor.

CORTINARIUS.

There are many species in this genus which are exceedingly attractive on account of their beautiful colors, but as it is difficult for any one but an expert to identify them none are described in this bulletin. The gills are covered by a cobwebby veil, which adheres to the margin of the cap or remains as a delicate silky ring about the stem. The spores are rusty brown. Certain species of this genus are edible, while others are unpleasant, and some are extremely poisonous.

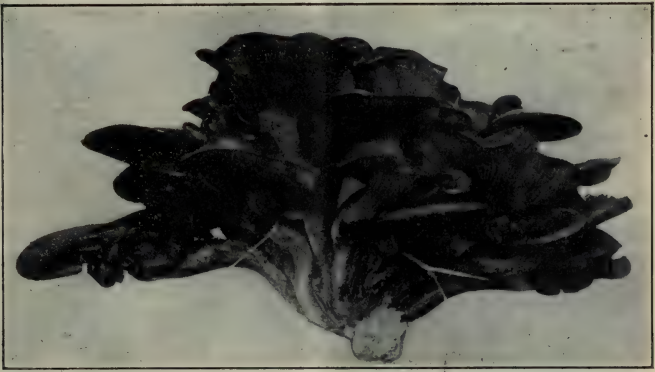

FIG. 10.—Jack-o'-lantern. (Poisonous.)

COMMON OR CULTIVATED MUSHROOM. AGARICUS CAMPESTRIS. (EDIBLE.)

In the common mushroom (fig. 14) the cap is fleshy, hemispherical, later becoming expanded and nearly flat. It is smooth, in color white or light brown, and the flesh is white and firm. The gills are white at first, later become pink, and finally blackish brown. The stem is stout, smooth, and furnished with a ring.

This is the cultivated and the best-known edible mushroom. It is not only of important commercial value, but being widely distributed and occurring abundantly in the wild state can be gathered safely by the ordinary collector of mushrooms. The only danger in collecting it is mistaking an Amanita for it; however, this difficulty will be entirely avoided by waiting until the gills are pink or changing to brown. This mushroom may be found in woods, but it grows most frequently in pastures and on richly manured ground.

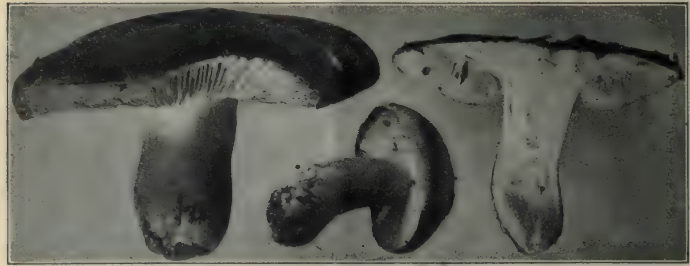

FIG. 11.—Equestrian tricholoma. (Edible.)

The *Agaricus campestris* is the only species grown commercially. It is cultivated in cellars, caves, and specially constructed houses.

COPRINUS MUSHROOMS.

In this genus the plants are fragile, the spores black, and the gills crowded, dissolving when old into an inky fluid. These mushrooms occur on dung or on richly manured ground, between the bricks of pavements, or on rotten tree trunks.

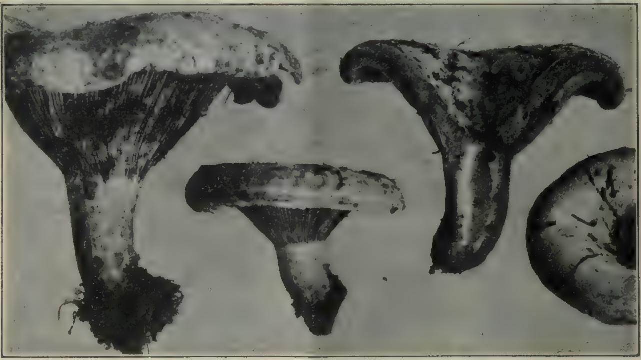

FIG. 12.—Indigo lactarius. (Edible.)

Inky-Cap Mushroom. Coprinus atramentarius. (Edible.)

In the inky-cap mushroom (see illustration on title-page) the cap is ovate, slightly expanded, silvery to dark gray or brownish, and silky or with small scales, especially at the center of the cap. The gills are broad, crowded, white, later pinkish, finally black and changing into an inky fluid. The stem is smooth, shining, whitish, and hollow; a ring low on the stem may soon disappear.

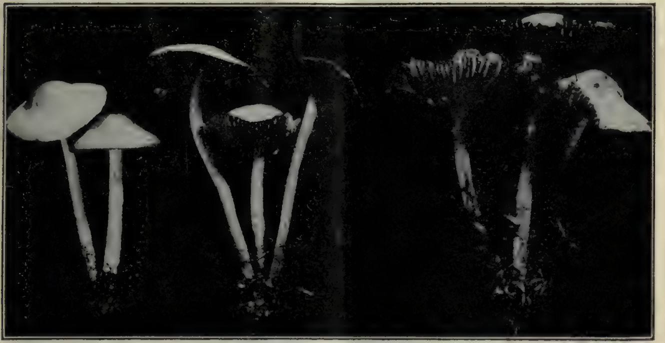

FIG. 13.—Fairy-ring mushroom. (Edible.)

The inky-cap mushroom is a good edible species that is adapted to various methods of cooking or can be used raw as a salad.

Shaggy-Mane Mushroom. Coprinus comatus. (Edible.)

In the shaggy-mane mushroom (fig. 15) the cap is oblong or bell shaped, white or yellowish, with shaggy, darker scales. The gills are crowded and broad. The stem is hollow, brittle, smooth, or with fibers, and has a thin, movable ring.

FIG. 14.—Common or cultivated mushroom. (Edible.)

The shaggy-mane fungus is recognized easily by its shaggy, bell-shaped cap and black spores and its habit of changing into an inky mass. It is an excellent edible species and, like the inky cap, appears in the spring and fall, solitary or in clusters.

DESCRIPTIONS OF MISCELLANEOUS FUNGI.

A great many conspicuous forms of fungi grow on various kinds of trees—forest, shade and ornamental, fruit, etc. These fungi are often found on living or dead trees, and economically may be either injurious or of very little importance. They generally gain entrance to a tree through some mechanical injury, as an exposed surface resulting from lightning or wind, borings of birds, insects, or other agents. Fungi of this kind are known as wound parasites. (Fig. 16.) Some of the species on trees belong to the gill fungi (Agaricaceæ), but many of them belong to the pore fungi (Polyporaceæ). In the latter class, instead of the spores being on gills, the lower surface of the cap is composed of numerous tubes, in which the spores are produced. (See fig. 1, *B*.) Sometimes these tubes are quite shallow; again they are deep and sometimes composed of several layers of tubes. Many of the species are tough and woody, but certain kinds are fleshy and edible.

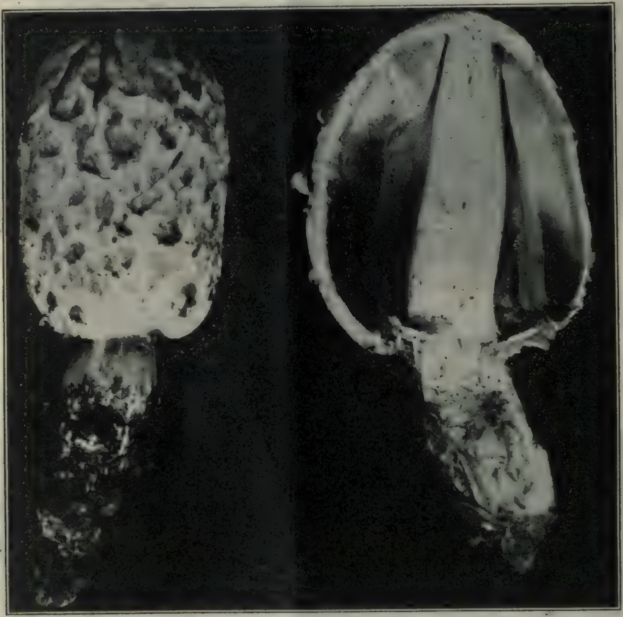

FIG. 15.—Shaggy-mane mushroom. (Edible.)

Descriptions of a few of the most common and conspicuous forms are here given.

BOLETUS.

In general appearance plants of the genus Boletus resemble species of Agaricus. There are a cap and a central stem, but instead of gills there are pores. Most of the species grow on the ground, but occasionally they are found growing on decayed trees. Certain species of this genus are edible, but they are difficult to determine and therefore will not be described in this paper.

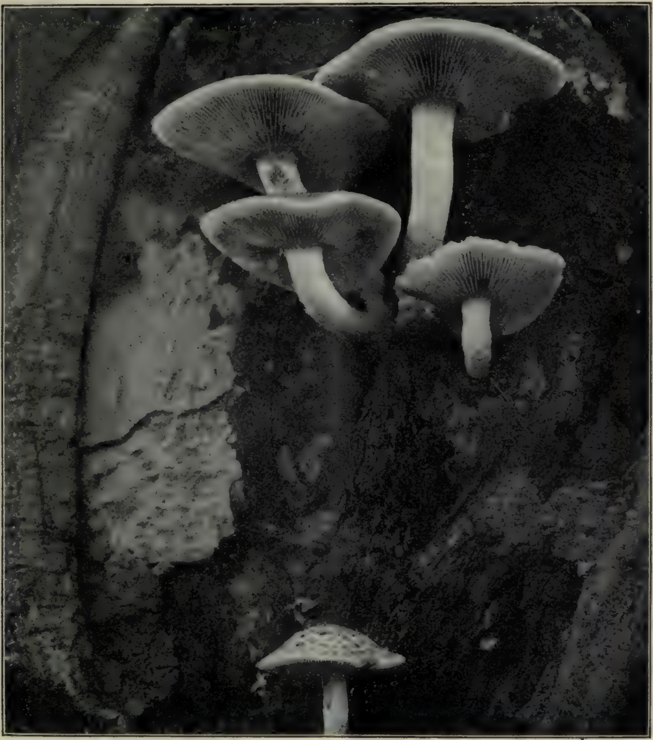

FIG. 16.—Mushrooms growing from a wound in a living tree.

POLYSTICTUS.

The species of this genus are sometimes wound parasites—that is, fungi which have gained entrance to a tree or other host through a wound or injured surface. Certain of the species grow on the ground and have a stem, but most are found on trees and are shelving and sessile, i. e., without a stem.

Species of this genus are thin and pliant and often very attractive in appearance, but they are tough and have no food value.

Polystictus versicolor.

In this fungus the caps are thin and shelving and marked by bands of different shades of color, mostly brown. The pores are white and do not extend quite to the margin. The plants are found growing in dense clusters on many kinds of trees.

Polystictus pergamenus.

In general appearance—that is, shape, consistency, and manner of growth—this species resembles *Polystictus versicolor*. It may be distinguished, however, by the lavender color of the pores.

BEEFSTEAK FUNGUS. FISTULINA HEPATICA. (EDIBLE.)

In this species (see fig. 1, *C*) the plants grow out horizontally from the trunks and stumps of living or dead trees. The caps are blood red when fresh, liver shaped, with a wavy or scalloped margin, and the flesh is thick, soft, and juicy. A stem is sometimes present; but if so, it is short and lateral. The pores are yellowish, at first short, later longer, and separate from each other.

This is a very good edible species and is most commonly known as the beefsteak fungus, though it is sometimes called beef tongue, oak tongue, or chestnut tongue.

WEEPING MERULIUS. MERULIUS LACRYMANS.

This fungus has no definite shape, and its soft, gelatinous surface is made up of irregular folds or wrinkles, which do not form pores, but give the growth a pitted appearance. It is first white, then flesh colored, and later orange brown. It causes a very destructive timber rot and is especially injurious to the wood in damp cellars and in houses which are poorly ventilated.

CORAL FUNGI. CLAVARIACEÆ.

The common name of these plants was given them on account of their resemblance to coral. They are erect, club shaped, simple, or branched. (See fig. 1, *D*.) Many species are very beautiful on account of their color, which may be lavender, orange, pink, cream, or white. Certain members of this family are edible, but as the species are difficult to recognize and as cases of poisoning have been reported, it is safer to let all coral fungi alone.

PUFFBALLS. LYCOPERDACEÆ.

Plants belonging to this family are irregular, ball shaped, sometimes with a stemlike base. When young the interior is white and firm; later it becomes yellow and finally breaks up into a brown or purplish powdery mass. Most species grow on the ground, but a few are found on rotten logs.

Puffballs must be eaten only when young and while the flesh is white; after the flesh begins to turn yellow the plants are unwholesome and indigestible.

Pear-Shaped Puffball. Lycoperdon pyriforme.

This species (fig. 17) is a very common little puffball, appearing in dense clusters on decayed stumps or logs.

Giant Puffball. Calvatia gigantea.

Giant Puffball. Calvatia Gigantea.

The giant puffball (fig. 18) is one of the largest and most delicious of the species belonging to this family.

STINKHORN FUNGI. PHALLACEÆ.

The presence of plants belonging to this family is quickly detected by the disagreeable odor emitted as the plants mature. The species most commonly found is *Ithyphallus impudicus* (fig. 19). In the young stage it resembles a gelatinous egg with threadlike strands at the base. In the central portion of the egg is a tubular part which elongates and bursts through the outside cover.

MOREL. MORCHELLA ESCULENTA. (EDIBLE.)

This fungus (fig. 20) is very easily distinguished on account of its resemblance to a sponge. The plants are brittle and have a short stem. The upper part is conical in form, prominently ridged, and has irregular depressions or cavities. The color varies from dingy yellow to tawny or grayish.

The morel has long been considered, both here and abroad, an excellent edible species. It has a wide distribution and occurs especially in damp situations and on sandy banks.

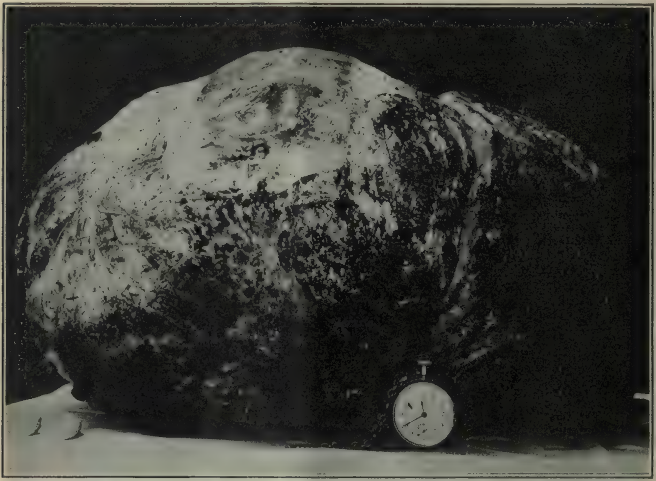

FIG. 18.—Giant puffball. (Edible.)

PRECAUTIONARY MEASURES.

As already stated, the collector should not use mushrooms or any fungi for food unless he is certain as to their identity. He should also bear in mind that poisonous mushrooms may appear in a bed of cultivated mushrooms. They do not grow from the spawn furnished by the dealer, but may be brought in with the material used for making the beds. The grower should be perfectly familiar with the cultivated plant in order not to mistake a wild and poisonous fungus for the edible mushroom.

In case of mushroom poisoning a physician should be summoned immediately, but an emetic should be given before his arrival. Warm salt water or mustard water may be used for this purpose.

His method of treatment will depend upon what mushroom has caused the poisoning and the symptoms and condition of the patient. The physician probably will come prepared to administer apomorphin and such stimulants as atropin, digitalin, and strophanthin.

RECIPES FOR COOKING MUSHROOMS.

According to the views of many persons, mushrooms are best cooked simply, with no seasoning but butter, pepper, and salt. The addition of various seasonings impairs the delicate mushroom flavor. However, tastes differ, and the opportunity of choice or experiment is afforded by the recipes which follow. All have been either tried by the writers or selected from the printed directions of capable authorities on culinary matters.

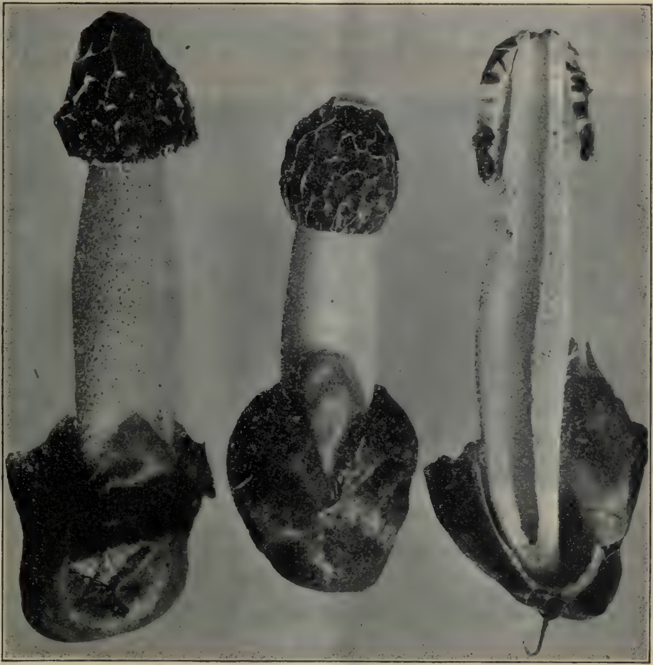

Fig. 19.—Stinkhorn fungus. (Inedible.)

Mushrooms may be prepared for the table in any way which would be suitable for oysters.

The caps should be carefully washed, gill side down, but peeling is not always necessary and involves a considerable waste of time and loss of flavor. Unless the stems are extremely tough they can be used after being cut into small bits and stewed, or, even if tough, after long boiling they can be run through a sieve and made into a soup or sauce.

Wild mushrooms should be cooked soon after collecting, as they are then preserved much better than if kept uncooked, even in a refrigerator.

Some thin, juicy, wild varieties, such as species of Coprinus, may require stewing from 5 to 10 minutes, while thicker, tough plants may require 30 to 40 minutes. Some mushrooms which never become tender by stewing may prove to be excellent when fried.

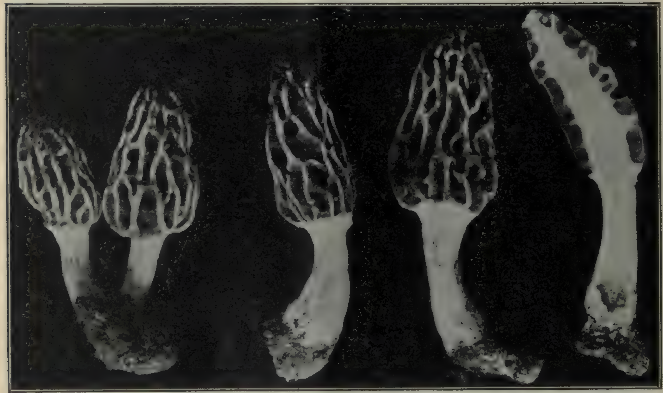

FIG. 20.—Morels. (Edible.)

Creamed Mushrooms.

Cut the mushrooms into small pieces, stew slowly in butter until tender, add cream or milk, pepper, and salt, and thicken with flour.

Fried Mushrooms.

Beat the yolk of an egg with a tablespoonful of water and season with pepper and salt. Dip each cap in this and then dip into fine cracker crumbs or corn meal. Have butter or cooking oil very hot in a frying pan. Fry slowly on each side for five minutes. A sauce can be made by thickening with flour and adding milk or cream. If desired, serve on toast. A smooth tomato sauce is also excellent.

Deviled Mushrooms.

Chop or break into small pieces 1 quart of mushrooms, season with pepper and salt; prepare 1 pint of bread crumbs; mix the mashed yolks of two hard-boiled eggs with two raw ones and stir into a cup of milk or cream. Put a layer of crumbs in the bottom of a baking pan or dish, then a layer of mushrooms; scatter over bits of butter; pour on a part of the cream and egg mixture, and continue until the dish is full, having bread crumbs with butter for the top layer. Bake for 20 minutes, closely covered, in a hot oven; then uncover for about five minutes, or long enough for the top to be well browned. If preferred, water and lemon juice may be substituted for milk or cream.

Mushrooms with Bacon.

Fry the bacon, and on removing it from the frying pan keep it hot; cook the mushrooms on each side in the "fryings" and serve on a platter with the strips of bacon arranged as a border.

Several species are good prepared in this manner, but it is especially well suited to the common cultivated mushroom.

Mushrooms Baked with Tomatoes.

In a baking dish arrange small round slices of buttered toast; upon each piece place a rather thin slice of peeled tomato, salted and peppered; upon each slice of tomato place a fine, thick mushroom, gill side up; in the center of each mushroom put a generous piece of butter; season with pepper and salt. Cover the dish and bake in a hot oven for 10 minutes; then uncover and bake for an additional 5 to 10 minutes, as the mushrooms appear to require.

Peppers Stuffed with Mushrooms.

Cut the stem end of the peppers and carefully remove all seeds and the white membrane; chop or break the mushroom into small pieces, season with pepper and salt, press firmly into the peppers, and put a good-sized lump of butter on top of each. The water adhering to the mushrooms after washing will furnish sufficient moisture for their cooking.

Arrange the peppers on end in a baking dish, having the water with salt, pepper, and butter poured in to the depth of about 1 inch. Place the dish in a hot oven, cook covered for 15 minutes; then uncover and baste and cook for 10 or 15 minutes longer, or until the peppers are perfectly tender. An addition to the mushrooms of chopped cooked chicken or veal is a pleasing variation.

Mushrooms with Cheese.

Butter a baking dish; place in layers the mushrooms broken in small pieces and bread crumbs; add grated cheese, salt, pepper, and bits of butter; continue until the dish is filled, letting the top layer be a thin sprinkling of cheese. Cook covered in the oven for 20 minutes; remove the cover for 5 minutes before serving.

Cream of Mushroom Soup.

Stew for an hour or longer the caps and stems cut in small pieces; run through a colander, add cream or milk, thicken with flour, and add butter, salt, and pepper.

Salads.

For salads many mushrooms may be used raw (after being peeled), especially species of Coprinus and Clavaria and all puffballs. Tougher plants can be stewed, drained, and chilled before adding the dressing, which may be either a mayonnaise or a French dressing of oil with vinegar or lemon juice. Serve on lettuce.

Mushrooms Cooked with Cream under a Glass Cover or Bell.

With a small biscuit cutter cut round slices of bread; they should be about 2½ inches in diameter and about 1 inch in thickness. Cut the stems close to the gills from fresh mushrooms; wash and wipe the mushrooms. Put a tablespoonful of butter in a saucepan; when hot, throw in the mushrooms, skin side down; cook just a moment, and sprinkle with salt and pepper. After the rounds of bread have been slightly toasted, arrange them in the bottom of a bell dish and heap the mushrooms on them; put a little piece of butter in the center; cover over with the bell, which may be of glass, china, or silver; stand them in a baking pan, and then place in the oven for 20 minutes. While these are cooking, mix a tablespoonful of butter and one of flour in a saucepan, add either a half pint of milk or a gill of milk and a gill of chicken stock; stir until it boils; then add half a teaspoonful of salt and a dash of pepper. When the mushrooms have been in the oven the allotted time, take them out; lift the cover, pour over quickly a little of this sauce, cover again, and send them at once to the table.

SUGGESTIONS FOR CERTAIN SPECIES.

Honey-Colored Mushroom.

While not one of the best edible species, this is excellent when fried and served on toast, and it is also good when stewed.

The Chanterelle.

The chanterelle, being rather tough, requires long and slow cooking.

"Cut the mushrooms across and remove the stems; put them into a closely covered saucepan, with a little fresh butter, and sweat them until tender, at the lowest possible temperature. A great heat always destroys the flavor."[1]

Coprinus.

The species of this genus are very delicate, *Coprinus micaceus* being considered the most easily digested of all mushrooms. They are good when steamed for five minutes and served with butter or cream.

Species of Coprinus are also delicious baked with cheese. Butter a baking dish and put in a layer of mushrooms, bread crumbs, cheese grated or cut into small pieces, and season with pepper and salt. Repeat the process once or twice, according to the quantity to be prepared, adding a few small lumps of butter to the last layer. Bake for 15 or 20 minutes.

Beefsteak Fungus.

The beefsteak fungus should be sliced across the grain and soaked in salt water, the length of time varying with its age. The slice should be wiped dry and boiled or fried, then dressed with butter, salt, and pepper.

The fungus may be used raw for salad, dressed to suit the taste, stewed, or made into soup. The suggestion of its use as a foundation for a beefsteak pie is apparently worthy of experiment, as its resemblance to a good steak, in flavor if not in texture, is quite remarkable.

Fairy-Ring Fungus.

The fairy-ring fungus is especially popular when stewed and served with a brown sauce as an accompaniment to beefsteak. The species dries easily, and even those dried naturally in the open may be revived by soaking and then prepared for the table.

Fairy-ring pickles can be made after the fungi have been packed in jars by pouring over them highly spiced vinegar heated to the scalding point. They are ready for the table in about two weeks.

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[1] Hussey, Mrs. T. J. Illustrations of British Mycology, London, 1849; text accompanying Plate IV.

Morels.

All morels are delicious. Probably the best manner of preparing them is to stuff them with chopped cooked chicken or veal and moistened bread or cracker crumbs, seasoned simply with salt and pepper. The stalks should be split to permit the stuffing and then tied together before the morels are baked. In the covered baking dish there should be a very small quantity of water.

Oyster Mushrooms.

Take small specimens of the oyster mushroom or cut from large tender ones pieces the size and shape of oysters. Dip them in the beaten yolk of an egg to which a tablespoonful of water has been added and roll in cracker crumbs or corn meal. Season with salt and pepper. Fry in either deep fat, melted butter, or oil.

Puffballs.

Never use puffballs unless the inner part is perfectly white when sliced. They should be peeled and then can be dressed raw for a salad, stewed with cream and served either in patty shells or on toast, or fried. When fried simply in melted butter or oil they are fine; or the slices may be dipped in egg and cracker meal before being placed in the frying pan. A cream dressing is a delicious addition to fried puffballs.

The Equestrian Tricholoma.

This species is most excellent when fried; also when creamed and served as patties. A unique way of serving it is in a soup made with water, pepper, and salt, which will compare very favorably with a dish of extremely fine turkey broth. After straining—for it must be a clear soup—add a small amount of butter.

CANNING MUSHROOMS.

The process of canning mushrooms, either the cultivated or wild varieties, is simple, but requires careful attention to the details, as described in the method followed by the writers.

Special canning outfits may be purchased, but just as good results can be secured by devising a homemade apparatus. A wash boiler, having a tight-fitting lid and provided with a false bottom of wire netting or asbestos cut out to fit it, will serve as a good sterilizer (fig. 21). If wire or asbestos is not readily obtainable, slats of wood or a layer of excelsior may be substituted. The glass jars must not touch the bottom of the boiler.

Glass jars, preferably pints, with tops adjusted by a spring, are the most satisfactory for mushrooms (fig. 22).

To can the common cultivated mushrooms, select, if possible, young, unopened buttons, leaving not more than one-half inch of stem below the veil. This involves no waste of good material, for from the stems catsup or powder may be made. Wash the caps lightly, wipe, cut quickly in four pieces, and pack as tightly as possible in jars, adding neither water nor salt. The lids should be put on but the springs not tightened (fig. 22). Place as many jars as desired in the boiler, which should contain water to about two-thirds the height of the jars. Cover the boiler tightly and boil for 1½ hours on two successive days. Mushrooms contain a large amount of water and shrink greatly during the process; the contents of the jars should, therefore, be combined into fewer jars between successive boilings. Before each boiling, the mushrooms should be packed down, and if there are not enough at the third boiling to fill the jars, open each for a moment just before putting it in the boiler and add boiled water enough to fill. On completion of the third boiling tighten the caps by adjusting the spring.

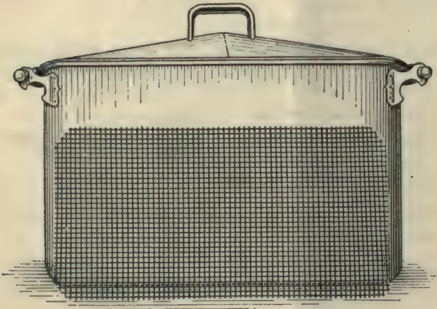

Fig. 21.—A tin wash boiler with a false bottom made of wire netting, used as a convenient sterilizer in canning.

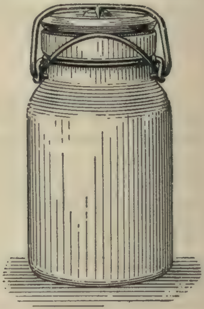

Fig. 22.—A jar with a glass top used for canning mushrooms, showing the spring as adjusted during sterilization.

DRYING MUSHROOMS.

Mushrooms may be preserved entire by drying them in the sun or in an oven. All moisture must be removed before the material is packed in a perfectly tight container. Mushrooms so preserved, after a preliminary soaking in tepid water or milk, may be cooked as if fresh.

Dried mushrooms, and even tough dried stems, may be ground and used as a powder for seasoning gravies and other dishes.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

SWEET CLOVER: GROWING THE CROP

H. S. COE

Assistant Agronomist, Office of Forage-Crop Investigations

FARMERS' BULLETIN 797

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. April, 1917

THE cultivation of sweet clover should be preceded by a thorough knowledge of the requirements for obtaining a stand.

The white species comprises a very large percentage of the present acreage of sweet clover.

Annual yellow sweet clover should be sown in no portion of the United States except the South and Southwest, and then only as a cover or green-manure crop.

Sweet clover is being cultivated in practically every State in the Union. At the present time the largest acreage is found in the western North-Central States and in the Mountain States.

Sweet clover is adapted to a wider range of climatic conditions than any of the true clovers, and possibly alfalfa.

Sweet clover will grow on practically all soil types to be found in this country, provided the soil is not acid and is well inoculated.

Sweet clover is more drought resistant than alfalfa or red clover. It is quite resistant to alkali.

The lime requirement of sweet clover is as high as that of red clover or alfalfa. Maximum growth is obtained only on soils that are not acid.

Sweet clover usually will respond to applications of fertilizers and manure.

In the more humid sections of the country good stands usually are obtained by seeding with a nurse crop.

Only seed which germinates 75 per cent or more should be sown in the spring of the year unless the rate of seeding is increased to make up for poor germination.

Sweet clover does best when seeded on a well-firmed seed bed which has only sufficient loose soil on the surface to cover the seed.

It is very essential that inoculation be provided in some form if success is to be expected.

The large number of failures in obtaining a stand of sweet clover are due primarily to acid soils, lack of inoculation, and seed which germinates poorly.

Spring seedings in general are satisfactory, but in the South excellent stands are obtained from midwinter seedings also. Fall seedings are usually successful south of the latitude of southern Ohio.

A Farmers' Bulletin (No. 820) on the utilization of sweet clover for pasture, hay, and as a green manure is about to be issued.

SWEET CLOVER: GROWING THE CROP.

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INTRODUCTION.

Sweet clover is an important forage crop in many regions. Although one of the oldest of known plants, not until very recently has it been considered seriously as a forage plant in this country. The principal causes for not utilizing this crop were its aggressiveness on uncultivated land in many localities, the tendency of the stems to become woody as they mature, and the refusal of stock to eat sweet clover before they had become accustomed to the bitter taste. Another reason was the fact that until recently red clover could be grown in the eastern half of the United States without difficulty. In northern Kentucky the continuous growing of tobacco or of tobacco and wheat impoverished the soil to such an extent that crops no longer could be grown successfully. Upon the abandoned farms in this section sweet clover was introduced as a honey plant. Owing to the remarkable yields of tobacco that were obtained on such farms after sweet clover had been grown for a few years the acreage of this plant increased very rapidly. For a number of years sweet clover has been grown on the Selma chalk (rotten-limestone) soils of Alabama and Mississippi as a soil-improving crop. At the present time it is being cultivated in practically every State, and the acreage is increasing very rapidly.

After it had been demonstrated that sweet clover would grow successfully on soils too depleted for other crops, many experiments were conducted to determine its value as forage. It was found that it was not only a valuable soil-improving crop, but that it made an excellent pasture and hay plant, quite palatable and rich in protein.

White sweet clover comprises a very large percentage of the acreage seeded to sweet clover at the present time. On this account this species ordinarily is referred to simply as "sweet clover." The yellow biennial species is designated as yellow sweet clover, and the annual yellow species as bitter clover, sour clover, or annual yellow sweet clover. This usage has been adopted in this bulletin.

The cultivation of sweet clover should be preceded by a thorough understanding of the requirements for obtaining a stand. It can not be grown successfully on all soils, as many assume from seeing it growing in uncultivated places. Neither will it thrive in many sections of the country without careful preparation of the seed bed. Sweet clover will not grow successfully in acid soils unless lime is applied, but it will make a good growth in soils too low in humus to grow red clover, provided the soil is neutral or alkaline.

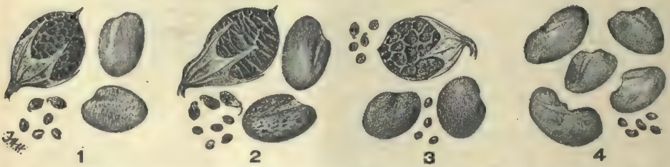

FIG. 1.—Seeds and seed pods of three species of Melilotus and seeds of alfalfa: 1, White sweet clover; 2, biennial yellow sweet clover; 3, annual yellow sweet clover, or sour clover; 4, alfalfa. The small figures in each drawing show the natural size of the seed. The venation and shape of the seed pods are important characters in distinguishing the different species of sweet clover.

Sweet clover is an excellent plant to precede alfalfa, as the large roots do much toward breaking up and aerating the subsoil. Contrary to the belief of many, it will not inoculate the soil for alfalfa unless inoculation is applied to the sweet clover. If, however, the soil contains but few inoculating germs, the sweet clover will serve as a medium to inoculate it thoroughly.

SPECIES OF SWEET CLOVER.

A number of species of sweet clover are found throughout the world, and most of them are native to temperate Europe and Asia as far east as Tibet.

White sweet clover,[1] yellow biennial sweet clover,[2] and yellow annual sweet clover[3] are the only species which have given sufficient promise as forage and green-manure crops in this country to warrant growing them under cultivation.

It is difficult for the average person to distinguish between the different species of sweet clover from an examination of the seeds or seed pods only. The differences are indicated in figure 1. Where there is a question as to the identity of a sample of seed it should be sent to a State agricultural experiment station or to one of the seed laboratories of the United States Department of Agriculture for identification.

WHITE SWEET CLOVER.

White sweet clover (fig. 2) is ordinarily referred to as melilotus or melilot in the South and merely as sweet clover in other portions of the country. When soil conditions are favorable for germination, sweet-clover seedlings will appear from one to two weeks after seeding. On account of the biennial nature of the plants, they do not seem to make much growth above ground the first month or six weeks after germination, but during this time they are developing root systems rapidly and thus becoming established, so as to be able to withstand adverse conditions. Plants which have made no more than 2 inches of top growth very often have produced roots 6 inches or more in length (fig. 3). The taproot continues to develop rapidly throughout the growing season the first year, and by autumn often reaches a length of 24 to 36 inches and a diameter of three-fourths to 1 inch at the crown.

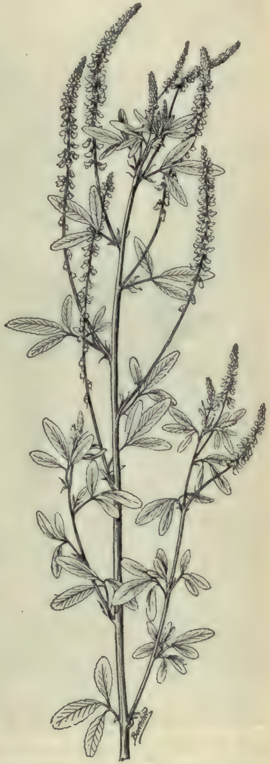

FIG. 2.—A branch of white sweet clover, showing the long, loose racemes which bear white flowers.

After the root system becomes established the plants produce an upright, branching, leafy growth, which under ideal growing conditions may reach a height of 48 inches the first season, but more often 18 to 30 inches. A large quantity of reserve food is stored in the taproot the first season; this reserve food enables the plants to make a rapid and vigorous growth early the following spring.

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[1] *Melilotus alba* Desr. [2] *Melilotus officinalis* (L.) Lam. [3] *Melilotus indica* (L.) All.

Toward the end of the growing season of the first year a number of buds, which serve to produce the second year's growth (fig. 4), are formed on the crowns of the plants. After these buds are formed the plants may be clipped quite close to the ground, as the buds are not developed until the plants have made sufficient growth to live through the winter.

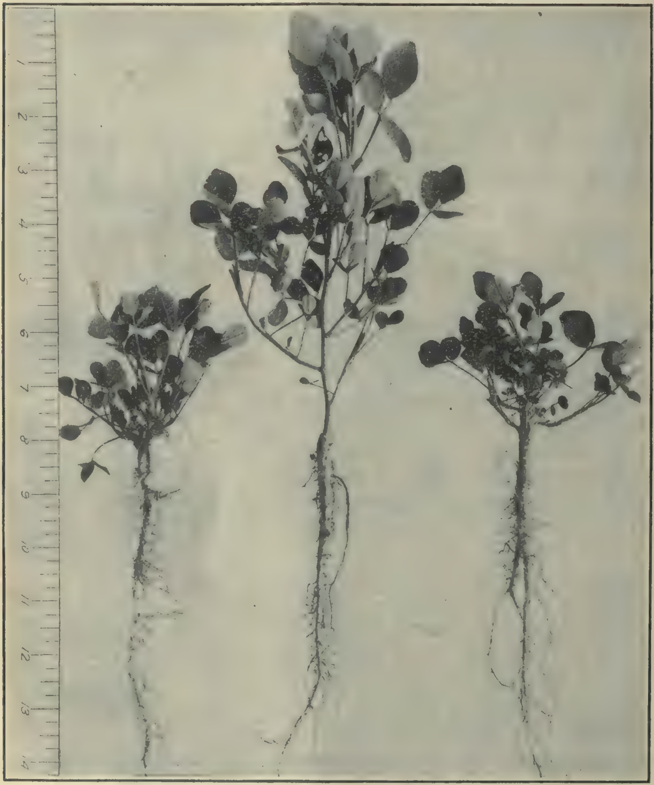

FIG. 3.—White sweet-clover plants collected from a plat six weeks from the date of seeding. An extensive root system such as is shown here is often developed before much growth is made above ground.

During the second season sweet clover makes a rapid, erect, stemmy, branching growth from 5 to 10 feet in height, the plants producing only a moderate number of leaves, which drop as the seed matures. A large number of loose racemes bearing white flowers (see fig. 2) are produced during the flowering period, which usually lasts from three to five weeks.

Before sweet clover has made a growth of 12 to 18 inches it closely resembles alfalfa. The plants may be distinguished from alfalfa by the absence of pubescence on the under side of the leaves and by their bitter taste. When they are in bloom they may be identified easily by their long, loose racemes of white flowers and their open, coarse growth. Unlike alfalfa, the seeds are ordinarily found singly in the pods. Two seeds may occasionally be found, and very rarely three, in a single pod.

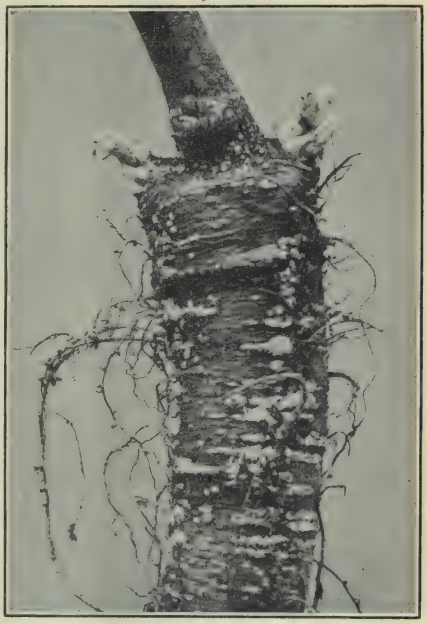

FIG. 4.—Buds produced on the crown of a sweet-clover plant at the end of the first season's growth. These buds will produce the first crop the second season.

STRAINS OF WHITE SWEET CLOVER.

A number of different strains of white sweet clover are to be found in the average field, but most of them are not as marked or as conspicuous as the different strains of red clover. The principal differences between strains of sweet clover are in leafiness, habit of growth, and date of blooming.

Occasional plants are especially heavy seed producers and bear many pods containing more than one seed. Other plants bloom earlier than the average date for white sweet clover, and it may be possible by selecting such strains to find one which matures early enough to produce two crops a season at high altitudes in the northern sections of the United States.

Fields of an exceptionally early blooming strain were found in Illinois, Iowa, and North Dakota in the summer of 1916. The plants were different in type of growth from the ordinary white sweet clover, being most conspicuous from the fact that they were in bloom during the first week of June, which is at least three weeks earlier than the ordinary species should bloom in those localities.

An annual white-flowered sweet clover was found in several localities in the fall of 1916. The seed which produced these plants was grown in Alabama. These plants resembled *Melilotus alba* in most respects except that they were strictly annual. They flowered and matured seed abundantly in South Dakota and North Dakota. It

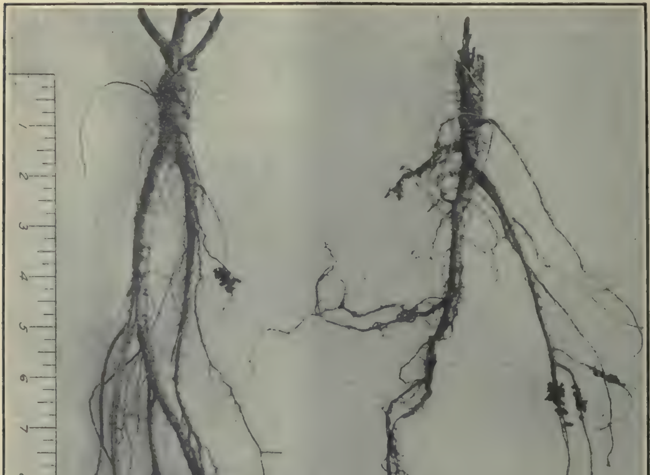

FIG. 5.—Root of white sweet clover (on the left) and of biennial yellow sweet clover (on the right). These roots were collected on October 28, 1915, at Arlington, Va., from adjacent plats seeded to oats and sweet clover on April 10, 1915. Note the difference in the size of the roots. Tubercles are present on the right-hand side of each root.

has not been determined whether this is a distinct species or merely an annual strain of the species mentioned.

BIENNIAL YELLOW SWEET CLOVER.

Biennial yellow sweet clover ordinarily is referred to in the seed trade and among farmers in regions where it is grown simply as yellow sweet clover. The plants of this species are somewhat smaller, more decumbent the first year, and ordinarily with more deeply notched leaves than the white-flowering species. Yellow sweet clover usually grows from 3 to 5 feet in height. This plant blooms from 10 to 14 days earlier than the white species, and for this reason it is advisable to sow seed of both plants when they are to be used for bee pasturage. On account of the finer stems of yellow sweet clover it is preferred in some localities for hay, but since it does not produce as much forage as white sweet clover and there is much less demand for the seed, it constitutes only a very small percentage of the total acreage. The much larger root growth of the white species, as illustrated in figure 5, is desirable because of the additional quantity of humus added to the soil.

The seeds of the yellow species may usually be distinguished from those of other species, as some of them are slightly mottled with purple. The shape of the calyx, which is generally present on unhulled seed, and the venation of the seed pods also distinguish it. (See fig. 1.)

ANNUAL YELLOW SWEET CLOVER.

Annual yellow sweet clover, more commonly known as sour clover or bitter clover, is found chiefly in the South and Southwest. This plant is considered a noxious weed in grain fields throughout the Southwest. It is claimed that the flavor of the seed which is imparted to wheat can not be removed. Bakers decidedly object to this flavor, stating that it injures bread. Sour clover is grown rather extensively as a green-manure crop in orchards in portions of Arizona and southern California and when properly handled in these regions it has given profitable results. As the seed is obtained from the screenings of wheat, it is offered on the market at a very low price. Occasionally it is sold for the yellow biennial sweet clover. Seed of this plant should not be sown in any part of the United States except the extreme South or Southwest, and then only as a green hay manure crop. Where it is desired to plant sweet clover for pasturage or for the biennial white or biennial yellow species should be used.

OTHER SPECIES OF SWEET CLOVER.

Thirteen species of sweet clover have been tested by the Office of Forage-Crop Investigations to determine their economic value. With the exception of white sweet clover, yellow biennial sweet clover, and yellow annual sweet clover, but four species in the somewhat limited tests have given sufficiently good results to merit special attention, and none have so far proved superior to white sweet clover, which is now extensively grown in many States.

A species of Trigonella[1] is often referred to as blue-flowered melilotus or blue-flowered sweet clover. While this plant is closely related to the plants belonging to the genus Melilotus, it does not belong to this genus and therefore should not be called sweet clover. It is an erect, quite leafy, very fragrant annual, which produces a fair growth. It may prove of value as a green-manure crop or as a catch crop under certain conditions, but at the present time it is not to be recommended where sweet clover can be grown successfully. In most tests Trigonella has produced less forage than the better species of sweet clover.

HISTORY.

Sweet clover has been used as a honey plant and for forage and green manure for more than 2,000 years in the Mediterranean region, although it has never been considered of much importance.

The first authentic report of sweet clover in the United States was in 1739, when Gronovius stated in his Flora Virginica that it was collected by Clayton. Cutler reported its presence in New England as early as 1785, and Pursh in 1814 stated in his Flora Americæ Septentrionalis that it is found on the gravelly shores of rivers from Pennsylvania to Virginia. Elliott reported the presence of yellow biennial sweet clover in his Sketch of the Botany of South Carolina and Georgia in 1824, and Beck found the species *Melilotus leucantha*[2] in the Northern States in 1833.

In 1856 Prof. Tutwiller, of Green Springs Academy, Ala., received a small quantity of white sweet-clover seed from the secretary to the United States consul in Chile. Part of this seed was planted by a young man named Strudwick on his father's plantation on the prairie limestone belt, where it flourished. This plantation later became the property of J. T. Collins, who, realizing the value of this plant, sold seed to persons in many States. Not until recently has sweet clover been grown to any extent as a cultivated crop in this country.

DISTRIBUTION.

While sweet clover is to be found growing in many countries and on all the continents of the world, it is native to temperate Europe and Asia as far east as Tibet. It is grown to a limited extent in

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[1] *Trigonella coerulea.*

[2] Undoubtedly meaning *Melilotus alba.*

England, while in the eastern part of Scotland a small quantity is considered valuable in hay on account of its agreeable odor. The famous Cruyere cheese of Switzerland owes its flavor to yellow sweet clover. In Germany it has given very good results when used as a green manure, while in parts of Russian Poland and Austria-Hungary it is grown as a green-manure, pasturage, and hay crop on poor soils. This plant is used for forage and as a soil-improving crop in the central provinces of India, while sour clover, commonly referred to as *Melilotus parviflora*, is credited with furnishing 75 per cent of the feed for the cattle of King Island, Tasmania, which produce the best beef and butter sold on the Tasmania market.

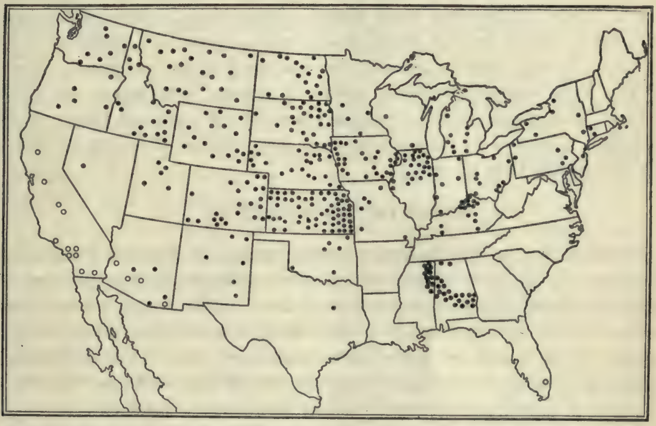

Fig. 6.—Outline map of the United States, showing the localities where sweet clover is grown for forage or for green manure. Each dot or circle indicates a county where 50 acres or more is grown under cultivation. The solid dots represent white or yellow sweet clover; the circles represent annual yellow sweet clover.

At the present time sweet clover is grown rather extensively as a field crop in the limestone regions of Alabama, Mississippi, and Kentucky, in northern Illinois, and throughout the western North-Central and Mountain States (fig. 6); in fact, it is grown as a cultivated crop to some extent in nearly every State in the Union. Comparatively little sweet-clover seed is sown in the Atlantic Coast States, since there the soils are for the most part acid, and heavy applications of lime will be necessary before sweet clover can be grown successfully. It is questionable whether this plant will ever be of much importance in the South Atlantic States, as cowpeas, soy beans, and crimson clover will make a fair growth on those soils in their present condition. The acreage of sweet clover probably will increase in the New England States, where it should prove of value as pasturage and as a soil-improving crop on soils where red clover no longer can be grown. Sweet clover grows abundantly in the limestone regions of northwestern New York.

A much larger acreage of sweet clover is grown in northern Illinois than in any other of the eastern North-Central States. The conditions in the western North-Central States and in the Mountain States appear to be particularly adapted to this crop. It is in that part of the country that the largest acreage is found, and, with the exception of the limestone regions of the South, that the least difficulty is experienced in obtaining a stand.

In those parts of the Mountain and Pacific Coast States, especially Utah, where it has not been tested carefully or where red clover or alfalfa can be grown successfully, sweet clover is looked upon as a weed. It may rightly be considered a weed in the irrigated regions of the West and Northwest, where it grows luxuriantly on ditch banks. The dissemination of this plant in all parts of the country has been hastened by beekeepers who have seeded it in waste places for the production of honey.

CLIMATIC ADAPTATIONS.

Sweet clover is adapted to a wider range of climatic conditions than any of the true clovers and possibly alfalfa; in fact, it may be grown successfully in any portion of the United States except, perhaps, Florida, and in Florida trials with biennial yellow sweet clover, annual sweet clover, and *Melilotus suaveolens* have been successful. Apparently neither the high temperatures of the South nor the cold winters of the North severely affect the plants, provided there is sufficient moisture in the soil. Comparatively little winterkilling is experienced in Montana, Wyoming, Idaho, and North Dakota when the seed is sown in close drills or broadcasted. Although approximately 50 per cent of the sweet clover seeded in rows 3 feet apart at Moccasin, Mont., was killed by the unusually severe winter of 1915–16, no winterkilling was noted in plats seeded in close drills.

Sweet clover thrives in the more humid parts of the country, as well as in the semiarid regions where the rainfall is but three-fifths of that required for the normal growth of such crops as red clover and timothy. In the semiarid regions of the West sweet clover has proved to be somewhat more drought resistant than alfalfa.

REQUIREMENTS FOR OBTAINING A STAND.

The requirements for obtaining a stand of sweet clover are somewhat exacting. It is for this reason that so many failures have been experienced. It must not be assumed, because sweet clover is found growing luxuriantly in many waste places and on uncultivated land, that a stand may be obtained by planting it at any time of the year, in any manner, and under all conditions. Throughout the eastern and southern portions of the country, with the exception of a few regions rich in limestone, much care must be used in the preparation of the seed bed, the selection of seed, and the manner of seeding if success is to be expected. For this reason it is necessary to understand fully the requirements for obtaining and maintaining a successful stand.

SOILS SUITABLE FOR SWEET CLOVER.

Sweet clover thrives on the adobe and granitic soils of the Pacific coast; upon the gumbo, hardpan, prairie, and sandy soils of the western North-Central States; and upon the heavy clay, loam, limestone, and sandy soils of the South and East. In fact, it has been grown successfully on all the principal soil types of the United States where the soils were not acid and were well inoculated. It grows luxuriantly on the Selma chalk (rotten-limestone) soils of Alabama and upon soils rich in calcium carbonate in many parts of the country where the lack of nitrogen and humus has caused large numbers of farms to be abandoned. The plants thrive on newly exposed heavy clay soils and upon steep embankments where little else will grow. Sweet clover is more tolerant of poor drainage, overflow, and seepage conditions than alfalfa. In irrigated sections, especially where the reservoir system is in use, large bodies of land are likely to become useless for the growth of alfalfa because of the rising of the water table. On such areas sweet clover will make a vigorous growth. However, maximum growth is to be expected only on well-drained soil.

Sweet clover will do well on many soils which are not fertile enough to grow red clover or alfalfa, and it is on these soils that it will prove most valuable. Like many other plants, it makes its best growth on fertile soils rich in calcium carbonate, although it will make sufficient growth on poor soils which are not acid to warrant planting it on them. Many hilly pastures may profitably be seeded to sweet clover. It will not only make a valuable addition to the forage of these pastures but will improve the soil so that grasses will grow more abundantly. Some of the best pastures in the Middle West are composed of bluegrass, timothy, and sweet clover.

RESISTANCE TO ALKALI.

Sweet clover grows successfully on soils in the West which apparently are too alkaline for grains or alfalfa. The Wyoming Agricultural Experiment Station reports that it has obtained good yields of sweet clover on seepage land which is so strongly alkaline that no other plants except some of the native grasses will survive, while the California Agricultural Experiment Station found that sweet clover will withstand alkali to a remarkable degree. Prof. F. S. Harris, agronomist of the Utah Agricultural Experiment Station at Logan, claims that it is one of the most alkali-resistant crops grown in Utah, and that in 1913 and 1914 quite an industry developed in some parts of that State in growing sweet clover for hay and seed on land too alkaline for other crops.

In reply to a circular letter on the culture of sweet clover, approximately 100 county agents and extensive growers of this crop located in many parts of the West state that this plant is one of the most alkali-resistant plants grown in their respective districts. In Crook County, Oreg., a good stand was obtained from April seeding in 1915 on a 20-acre demonstration field of sandy loam bottom land so strongly alkaline from black alkali that only salt grass was growing on it before it was planted to sweet clover. This field pastured from 18 to 28 head of calves, cows, and horses from June 1 to October 1 without being irrigated. Sweet clover generally will grow on soils where salt grass[1] will survive, and it is very much superior to this grass as pasture. After the drainage of water-logged land on which there is a surface accumulation of alkali, it is the common practice in parts of Utah to grow sweet clover for several years before planting alfalfa. It is often stated that alkali land will grow less tolerant crops after sweet clover has been grown on it for a few years. The long roots will open up the subsoil and cause better drainage, thereby affording an excellent means for removing the salts from the soil, as they are readily soluble in water.

NEED OF LIME ON ACID SOILS.

Sweet clover, like many other legumes, requires a soil containing an abundance of limestone if a maximum growth is to be expected. Throughout the world it makes a luxuriant growth only on calcareous soils. On the black prairie limestone soils of Alabama and Mississippi it grows luxuriantly, although in this region it is very seldom found on the outcroppings of red clay, which are acid. The distribution corresponds sharply with the line of demarkation between the black prairie soils and other soil types. In some places sweet clover makes a vigorous growth on the Selma chalk (rotten-limestone) soils, while none is to be found on red post-oak clay but a few yards away; yet sweet clover will grow on the red post-oak clay after the soil has received an application of lime. It will thrive on the bald lime-rock spots and rotten-limestone hills of Mississippi, which are so barren that practically no other plants will survive.

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[1] *Distichlis spicata.*

Thus it appears that lime is essential for the maximum growth of sweet clover in this region.

The reason for the exceptional growth of sweet clover in north-central Kentucky is undoubtedly the fact that these soils contain an abundant supply of limestone. The Kentucky Agricultural Experiment Station states that this area is the only portion of the State where sweet clover is being grown with general success without applying lime.

Soils on which sweet clover is aggressive are almost invariably alkaline or but slightly acid. This plant is often found in valleys of streams in localities where the soils are supposedly acid, but such streams generally have their origin in limestone areas or flow through limestone regions, and calcium carbonate is thus deposited in these valleys during flood periods with the sedimentary deposits from flood waters. Sweet clover often appears in deep cuts along highways or railroads in localities where the soil is known to be acid and where sweet clover has not previously grown. In many of these cuts the acid soil has been removed and neutral or alkaline subsoil exposed, or limestone has been used in ballasting or road making and the dust has blown on the exposed soil. It is a very common occurrence to find sweet clover making an abundant growth along macadamized roads from which the wind has scattered the finely pulverized limestone.

An application of burnt lime or finely ground limestone has made the difference between success and failure in most experiments which have thus far been conducted on decidedly acid soils. (Fig. 7.)

A number of sweet-clover experiments were performed on acid soils and on adjacent plats or fields of the same type of soil that had received applications of limestone varying from 1 to 4 tons to the acre. There was a marked difference in the stands obtained and in the growth of the plants on the limed and unlimed areas. In some cases the difference in growth was so marked that the last round of the lime spreader could be distinguished at some distance from the plats. The stands were much heavier on the limed areas and the plants made from two to three times more growth than those on the unlimed plats. Yields of hay were doubled on soils that received only sufficient limestone to neutralize the acids in the surface soil, although the yields were further increased when more limestone was added.

Mr. W. E. Watkins, county agent of Allen County, Kans., made counts of the number of plants which winterkilled during the winter of 1914–15 on given areas of limed and unlimed soil. It was found that from 15 to 35 per cent more plants winterkilled on the unlimed soil than on the limed areas. That portion of the unlimed field on which the fewest plants winterkilled was found to have the lowest lime requirement. On the unlimed areas with a low lime requirement 15 per cent more plants winterkilled than on the limed areas; on those with a high lime requirement the increase in winterkilling was 33 per cent. In the fall of 1914 the hay cut from the limed areas exceeded that from the areas with a low lime requirement by 600 pounds per acre and exceeded that from the areas of high lime requirement by 4,000 pounds per acre. In July, 1915, the increase in hay yield on the limed areas over that from the areas with a low and with a high lime requirement was 2,300 and 9,400 pounds per acre, respectively. The area of high lime requirement returned a small yield in 1914 and no hay in 1915.

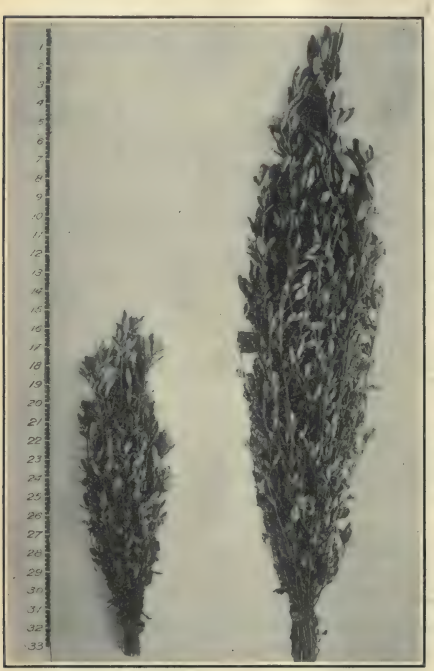

FIG. 7.—Sweet-clover plants, showing the effect of lime upon their growth. The plants at the left represent the average growth on the unlimed portion of a field; the plants at the right show the average growth on the limed part of the same field.

In spite of the fact that sweet clover is as sensitive to soil acidity as red clover or alfalfa, a large percentage of the acreage thus far seeded in the eastern half of the United States has been composed of acid soils, and this soil acidity undoubtedly is responsible for a very large percentage of the failures with sweet clover in this section. Where sweet clover is to be sown on acid soils a sufficient quantity of lime should first be applied to at least neutralize the acids in the soil to a depth of 6 inches. An application of 1 ton of burnt lime or 2 tons of finely ground limestone will usually be sufficient for this purpose.

Fields have been noted where sweet clover was making a fair growth on apparently acid soils. Such fields usually are rich in humus or phosphorus and are exceptional cases rather than the rule.

Soil types which have slightly acid surface soils and alkaline subsoils will grow sweet clover successfully, provided the acid soil is not more than 6 to 12 inches in depth.

FERTILIZERS.

Owing to the fact that sweet clover thrives on the barren Selma chalk (rotten-limestone) hills of Alabama and Mississippi and grows abundantly on worn-out, abandoned land in north-central Kentucky, it is often assumed that it will grow on soils too depleted in plant food to produce other crops. These regions represent soils which have become exhausted primarily in nitrogen and humus as the result of continuous cropping with nonleguminous plants. Some of these soils contain sufficient phosphorus and potassium for fair crop production, although this supply may be in such a condition that it will not become available fast enough to supply the needs of most crops. Sweet clover, like all legumes, has the power to extract nitrogen from the atmosphere, and on account of its extensive root system it is able to obtain phosphorus and potassium from a larger area than most plants. The large roots not only add a quantity of humus and nitrogen to the soil but they also open it up to a considerable depth, thus providing better aeration and improving its physical condition. Improved physical condition causes the bacterial flora to increase and thereby indirectly causes a larger quantity of unavailable phosphorus and potassium to be made available for plant use.

On soils which are known to be low in phosphorus or potassium an application of fertilizer containing the necessary element should be made when sweet clover is sown without a nurse crop. However, when it is sown with a nurse crop or in the late summer or early fall on grain stubble, the residues left in the soil from fertilizers applied to the nurse crop will, under ordinary conditions, be sufficient for the plants. That sweet clover will respond readily to applications of phosphorus on soils low in this element has been well demonstrated by the farmers of Livingston County, Ill. In this county finely ground rock phosphate was applied to a portion of a number of fields at the rate of 1,500 to 2,000 pounds per acre. The phosphate was thoroughly incorporated with the soil just before seeding oats and sweet clover. In the growth of sweet clover there was a marked difference the following year between the treated and untreated portions of the fields. Those portions of the fields which received an application of phosphate not only contained many more plants on a given area, but the vigor and growth of the plants were most marked. On June 1 the plants on the treated areas were 12 to 15 inches taller than those on the untreated parts of the fields. This difference in the thickness of stand and the height of plants was so striking that the last round of the phosphate spreader was plainly distinguishable.

Yields of sweet-clover hay have been increased as much as 2 tons per acre from applications of barnyard manure. Such an increased yield would be equal approximately to 8 tons of green manure. Some people may consider it poor farm practice to apply manure to such crops as sweet clover, but it is very probable that the cumulative effect of the increased yields of the following corps, especially on soils low in organic matter, will be greater than if the manure is applied to other crops. Heavy applications of manure to the preceding crop should also greatly benefit sweet clover.

USE OF A NURSE CROP.

If sweet clover is to become an important crop throughout the North-Central States it must necessarily be seeded with grain. Good success has been obtained by seeding sweet clover in the spring on winter grain or with spring grain on soil that was inoculated and not acid. Seed may be broadcasted in the early spring on winter grain when the ground is in a honeycombed condition, or it may be sown later when the ground may be cultivated. A large acreage of sweet clover is sown in the western North-Central States and in Illinois in the spring with oats, barley, or wheat as a nurse crop. Early varieties of oats and spring wheat have given somewhat better results in portions of the Northwest than barley. In Illinois oats are used almost entirely. Only a few fields were noted where flax had been used as a nurse crop, but in these fields it was successful. In wet seasons the sweet clover may make a growth sufficiently large to interfere seriously with harvesting the flax. On this account this combination should be tested thoroughly in an experimental way before being recommended for general field practice.

In those sections of the country where the moisture supply is limited, sweet clover should be sown without a nurse crop. Failure to obtain a stand is more likely to occur when the seed is sown with grain than when it is sown alone, because during dry weather, which is likely to occur when the grain is maturing, the supply of moisture in the soil is apt to be insufficient for both crops. When this condition prevails the clover will suffer badly and in some cases be killed. When sweet clover is sown with a nurse crop it is strongly recommended that the grain be seeded at not more than two-thirds the usual rate. This will give the sweet clover a much better chance than when a full seeding is made. When severe droughts occur it may be necessary to cut the grain for hay if the stand is to be saved.

CHOICE OF SEED.

On account of the low germination of much of the sweet-clover seed offered for sale it is very important that seed be tested for germination before planting. Low germination usually is due to the fact that many of the seeds remain hard after they have been in the germinator or soil for a month or more. The seed coats of hard sweet-clover seeds become permeable to water very slowly, if at all, in storage. The germination of such seeds is greatly increased, however, when they are subjected for a time to alternating temperatures, such as freezing and thawing. It is on this account that unhulled seed, which germinates poorly in the laboratory, often will produce good stands when sown during the winter. When sweet clover is to be sown in the spring it is very important that only hulled seed which germinates 75 per cent or more be sown. As explained later under the heading " Seeding," unhulled seed which has a low germination should be used for seeding only during the winter months, so that there will be sufficient time for the alternating temperatures of winter and early spring to cause it to germinate during favorable weather.

Hulled seed usually germinates much better than unhulled seed, as is shown in Table I.

TABLE I.—*Germination and hard-seed content of samples of sweet-clover seed, hulled and unhulled, from different sources.*

Description.	Number of samples.	Average percentage of—	
		Germination.	Hard seed.
Kind of seed:			
Hulled	237	53.25	18.7
Unhulled	45	11.8	70.9
Source of seed:			
Southern	22	14	60
Northern	22	37	43
Imported	28	56	12

Table I shows that northern-grown seed germinates better than southern-grown seed and imported seed better than either. The low germination of the southern-grown seed is probably due to the fact that a very large percentage of it is flailed out and sown in the hull. Northern-grown seed generally is thrashed with either a grain separator or a clover huller. Imported seed always is hulled. In hulling seed the rasps or concaves of the machines scratch the seed coats sufficiently to permit water to penetrate them, so that the germination is greatly increased. Apparently there is no reason why southern-grown seed when it is properly hulled should not germinate as well as northern-grown seed.

Since the Ames scarifying machine (fig. 8)[1] has been placed on the market, it is possible to buy scarified seed. This machine is so constructed that the seed is forced through a conveyer, part of which is covered with sandpaper. When the seed comes in contact with the sandpaper it is scratched, so that water will penetrate the seed coats. When this machine is run properly the germination of seed is greatly increased, but when carelessly operated germination may be lessened, as many of the seeds may be broken.

The retarded germination of sweet-clover seed may be overcome by soaking it in commercial concentrated sulphuric acid for 20 minutes. It should then be washed quickly, using running water if possible, as sulphuric acid becomes very hot when mixed with small proportions of water. A great deal of water therefore is necessary in order to lessen the danger of burning. The seed should be dried quickly by spreading it out on a floor or canvas, and it should be stirred at intervals. Unhulled seed should never be treated with sulphuric acid. When only a small quantity of sulphuric acid comes in contact with the hulls a very high temperature will result and the seed will be killed. The treatment of seed with sulphuric acid

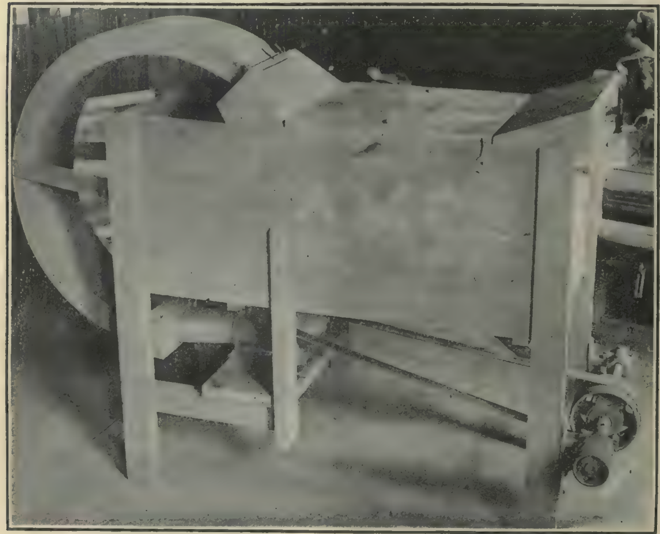

FIG. 8.—Ames hulling and scarifying machine.

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[1] This machine was invented by Prof. H. D. Hughes, of the Iowa State College at Ames. A United States patent covering this device has been issued and dedicated to the free use of the public.

for seeding on a field scale is not to be recommended, in view of the fact that as good or better results may be obtained by using scarified seed.

It is very important that seed of the desired species be obtained. Many lots of sweet-clover seed offered for sale on the market consist of mixtures of the yellow and white species, and many samples also are adulterated with alfalfa. Seed which is simply labeled sweet clover should never be purchased, as seed so labeled may be any one of the several varieties offered for sale. It is always best to state the specific kind of seed ordered and then submit a sample to either your State agricultural experiment station or one of the seed laboratories of the United States Department of Agriculture[1] for identification before purchasing.

The Seed Laboratory of the United States Department of Agriculture during the winter of 1915–16 obtained 172 trade samples of sweet-clover seed and, as may be seen from Table II, many of the samples were not true to name.

TABLE II.—*Trade samples received in response to requests for white sweet clover seed.*

Seed labeled—	Number of samples.	Seed when tested found to be—						
						Alfalfa and—		
		White sweet clover.	Biennial yellow sweet clover.	White and biennial yellow sweet clover.	Annual yellow sweet clover.	White sweet clover.	Biennial yellow sweet clover.	White and biennial yellow sweet clover.
White flowering sweet clover, white sweet clover, Bokhara clover, or Melilotus alba	147	91	10	28	....	13	1	4
Sweet clover	22	6	4	2	5	5	....	....
Not labeled	3	1	....	....	2	....	....	....
Total	172	98	14	30	7	18	1	4

PREPARATION OF THE SEED BED.

Sweet clover requires a well-settled and firm seed bed, with just sufficient loose soil on the surface to permit the seed to be well covered. When the seed is sown in the spring on winter grain the seed bed usually is in good condition. At this season of the year the seed may be sown, so that it will be covered by freezing and thawing weather. It may be sown also when the ground is in condition to cultivate and then may be harrowed or drilled in. When the seed is sown with spring grain the seed bed is not as firm as it should be for the prompt germination and establishment of the young clover plants. If sown in this manner the soil should be worked into a fine condition and firmed as much as possible. It is good practice to roll the ground with a corrugated roller after seeding. Better stands are usually obtained by seeding on fields that have been disked and harrowed than on those that have been plowed.

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[1] Samples of seed may be submitted for analysis or identification to the Seed Laboratory of the United States Department of Agriculture at Washington, D. C., or to any of the following laboratories maintained through the cooperation of the Department: Branch Seed-Testing Laboratory, Agricultural Experiment Station, Columbia, Mo.; Branch Seed-Testing Laboratory, Agricultural Experiment Station, Baton Rouge, La.; Branch Seed-Testing Laboratory, Oregon Agricultural College, Corvallis, Oreg.; Branch Seed-Testing Laboratory, Purdue University, La Fayette, Ind.; Branch Seed-Testing Laboratory, California Agricultural Experiment Station, Berkeley, Cal.

When sweet clover is seeded without a nurse crop it should not be sown on freshly plowed land which has had no opportunity to settle. The land preferably should be plowed several months before the seed is to be sown, and then worked at intervals with soil packers or harrows. Double disking and harrowing just previous to seeding are to be strongly recommended in preference to plowing at this time.

When sweet clover is to be seeded in the fall on grain stubble, the ground should be disked and worked into good condition as soon as the grain can be removed. If the seed is sown immediately the field should be rolled after seeding.

Fall-plowed ground ordinarily makes an ideal seed bed for spring seeding. Soil which has been previously planted to a cultivated crop, such as corn, is usually put in sufficiently good condition for sweet clover by disking. Good success has been attained by merely broadcasting the seed on sandy soil and scratching it in with a harrow. Such a seed bed appears to be ideal when the seed can be covered sufficiently to insure plenty of moisture. It must be remembered that young sweet-clover plants are not drought resistant and that every precaution should be taken in seasons of drought or on land which drought affects badly to so prepare the seed bed that the largest quantity of moisture will be conserved.

Excellent stands have been obtained at times by double-disking native prairie sod and either covering the seed with a harrow or sowing it with a drill.

SEEDING.

The proper time to seed sweet clover should be determined by the germination of the seed, the climatic conditions of the region, and the condition of the seed bed at the time of sowing. When growing under natural conditions, seed which has lain in the ground over winter germinates in sufficient quantity during the following spring to produce a stand. It is therefore assumed that since this seed has passed the winter on or in the ground and has produced a good stand the following spring, sweet clover may be sown at any time of the year and a satisfactory stand obtained. Little is thought of the enormous number of seeds which shatter from a single plant and fall on an area not exceeding 5 or 6 feet in diameter. Single plants have produced as many as 350,000 seeds (the approximate number in 1½ pounds), or about 10,000 seeds for each square foot of ground covered. It matters little how many of these seeds germinate in the fall they mature or during the following winter, when the seedlings will be killed by freezing, for there will be enough viable seeds left in the ground to germinate when conditions are favorable in the spring. Conditions are very different when sweet clover is sown on cultivated soil at the rate of 5 to 20 pounds of seed to the acre—25 to 100 seeds to the square foot. When this quantity is sown, it is necessary that it be planted at such a time that the greatest number of seeds will germinate and produce plants.

HULLED SWEET-CLOVER SEED.

Hulled seed makes up a large percentage of the sweet-clover seed sown. The germination of hulled seed varies considerably, although ordinarily it is higher than that of unhulled seed. Seeding experiments conducted at Arlington, Va., with seed which germinated 80 per cent show clearly that seed which germinates well should not be sown during the winter months in those sections of the country where midwinter thaws are likely to occur, and especially in sections south of the latitude of southern Ohio. In these experiments seed was sown during each month of the winter. Good stands were obtained only on those plats which were sown in the latter part of February and during March and April. At least 75 per cent of the seed sown during November, December, and January germinated on warm days during winter thaws and was killed by later cold weather. Notwithstanding the fact that sweet-clover seedlings will endure fairly low temperatures, seed germinating more than 50 per cent should not be sown during the winter months, and preferably not more than a week previous to the average date for the last severe freeze.

No data have been secured on winter seeding in those portions of the United States where open winters do not occur. It is probable that in those sections the winters are sufficiently cold to prevent germination before spring. Good results may be obtained by winter seeding, but as usually no trouble is experienced in those sections in obtaining a stand by seeding as soon as the soil can be worked in the spring, it is strongly recommended that seeding be done with hulled seed, which germinates well at this time of the year.

Many excellent stands have been obtained by seeding late in the spring, but in most sections seeding at this time is not as certain to produce a good stand as earlier seeding. Late spring seeding may be preferable when the ground is weedy and the clover is to be seeded without a nurse crop. Under these circumstances a crop of weeds may be destroyed before seeding.

Very good success has been obtained in the Southern and Central States, and in some of the Northern States, by seeding sweet clover in the late summer or early autumn. When there is sufficient moisture in the soil for germination and when good seed is used, better stands have been obtained by seeding about eight weeks before severe frosts are to be expected than from spring sowing. This is particularly true in regions where late spring droughts or severe summer droughts are likely to occur. Seeding at this time may be done after an early crop has been harvested and when weeds are not likely to be troublesome. Plants from fall seeding mature from 10 days to two weeks later the following season than plants from spring sowing of the same year. The later time of maturing is an advantage, in that the plants will be ready to cut during better haying weather. The root growth is not as large from fall seeding as from spring seeding, and therefore not quite as much humus is added to the soil. Late fall seedings are very likely to be injured from heaving on wet clay soils.

UNHULLED SWEET-CLOVER SEED.

Unhulled sweet-clover seed is sown principally in Kentucky, Alabama, and Mississippi. On the limestone soils of these regions, which appear to be naturally adapted to sweet clover, very good results are obtained by using unhulled seed. It is not because southern-grown unhulled seed germinates better than northern-grown unhulled seed that better stands are obtained in the South from it, but it is mainly because southern farmers better understand the somewhat exacting conditions necessary for obtaining a stand with this kind of seed. Unhulled sweet clover contains a large percentage of hard seeds which will not germinate until they have been in the soil for some time and have been subjected to varying temperatures.

Seeding experiments have been conducted at Arlington, Va., where unhulled seed which contained 90 per cent of hard seed was sown during each month of the winter. Good stands were obtained on those plats seeded at the rate of 24 pounds (3 pecks) of seed to the acre during December and January, and fair stands on the plats seeded at this rate in February. Later seedings failed to produce a stand.

A large percentage of the unhulled seed sown in the South is seeded during January and the first part of February. Good stands are seldom obtained from unhulled seed south of the latitude of Washington, D. C., when the seed is sown later than the middle of February.

The use of unhulled seed has usually been attended with failure in the northern portion of the United States, although occasionally good stands have been obtained the following spring from late fall seeding. This failure is in part due to the fact that the seed has been sown in the spring and at a time when only seed germinating well should be used. When unhulled seed is to be sown north of the latitude of Washington, D. C., it should be sown not later than February 15, and preferably earlier. Observations show that fairly good stands may be obtained by seeding during the winter, but care should be taken not to sow seed earlier than necessary on land which is subject to washing. Farmers should have no trouble in purchasing hulled seed, and therefore it is recommended that only hulled seed which germinates well be sown.

RATE OF SEEDING.

The rate at which sweet clover should be seeded varies with the germination of the seed, the condition of the seed bed, the climatic conditions of the region, and the method of seeding. Throughout the humid sections of the eastern United States sweet clover ordinarily is seeded at the rate of 15 to 20 pounds of hulled seed to the acre. From 12 to 15 pounds should be ample where the seed bed is in good condition and the seed germinates 75 per cent or more. In Illinois, the western North-Central States, the Mountain States, and the Pacific Coast States good stands are generally obtained by sowing 10 to 12 pounds of hulled seed to the acre. In eastern Washington it is claimed that from 5 to 8 pounds to the acre are sufficient for good stands.

When sweet clover is grown under irrigation, 8 to 10 pounds of hulled seed usually are sufficient, and from 2 to 4 pounds per acre are enough when seeded in rows from 2 to 4 feet apart. Of unhulled seed 3 to 6 pecks (24 to 48 pounds) or 20 pounds of hulled seed are usually sown in the South for pasturage or hay. In any region at least 10 pounds more of the unhulled than of hulled seed should be sown to an acre. Unless annual yellow sweet-clover seed is thoroughly cleaned it should be sown at the rate of 25 to 30 pounds to the acre.

METHODS OF SEEDING.

The methods used for seeding red clover or alfalfa in any particular region will be suitable for seeding sweet clover. Good results have been obtained by broadcasting the seed on winter grain in the spring when the ground is in a honeycombed condition. Perhaps a better method is to wait until the ground can be worked and then to broadcast and cover the seed with a harrow or to sow it with a drill. Unhulled seed is usually broadcasted, since it is necessary to sow it before the ground is in condition to be worked. Unless the hulls have been rubbed smooth, some difficulty may be experienced in seeding it evenly with a drill.

When sweet clover is to be sown with spring-seeded grain or when it is to be sown without a nurse crop it may be drilled in or sown broadcast and covered with a harrow. Better stands are generally obtained with a smaller quantity of seed when it is sown with the drill than when it is broadcasted on honeycombed ground. When the seed is sown at the time the grain is planted, the grass-seeder attachment of the drill commonly is used. In some sections the end-gate seeder is used almost entirely. When the seed is sown by either of these methods it may be seeded alone or mixed with the grain. When only the clover seed is sown with a drill, the alfalfa and clover seed drills are to be preferred.

Sweet-clover seed may be mixed with some inert substance of approximately the same size and weight and sown with an ordinary grain drill. Finely cracked corn, cracked wheat, or coarse bran often are used for this purpose. When one portion of sweet clover is mixed with two portions of a filler and the drill is set to sow one-half bushel of wheat, it will usually sow from 15 to 20 pounds of sweet clover to the acre. As this quantity will vary with the different types of drills, it is necessary to test each drill, so that the seed may be mixed with the filler in such proportions that the desired quantity will be sown. The drill may be tested by blocking it up, so that the geared wheel is off the ground, and this wheel may be turned a sufficient number of times to equal a definite portion of an acre. The seed that runs through can then be weighed and the rate per acre determined. The rate may be determined more accurately by plugging up the grain tubes or by tying a small sack on each tube and pulling the drill for a specific distance over the field to be sown. The jar of the drill will cause it to drop more seed than when it is blocked up and run by hand.

It is often desired to seed sweet clover on land which can not be cultivated. When sown on such land it is recommended that unhulled seed or seed that contains a large percentage of hard seed be used and that it be broadcasted during the winter. The subsequent freezing and thawing will cover many of the seeds and cause them to germinate. It is a good plan to scatter in deep gulleys mature plants that have not shattered all their seed. The branches of these plants will help to hold the seed in place until it germinates and the young plants become established.

Seed may be scattered on native prairie ground in the late winter, but unless it is trampled into the ground by live stock disappointing results are likely to be obtained at first. Fair results have been secured by planting seed with disk drills on prairie sod after it had been double-disked in the early spring. This method should be used in preference to broadcasting the seed and depending on cattle to trample it in. Mr. George Hummer, of Prairie Point, Miss., reports good success in his locality by simply broadcasting 1 peck of unhulled seed on Bermuda-grass sod not later than January 1.

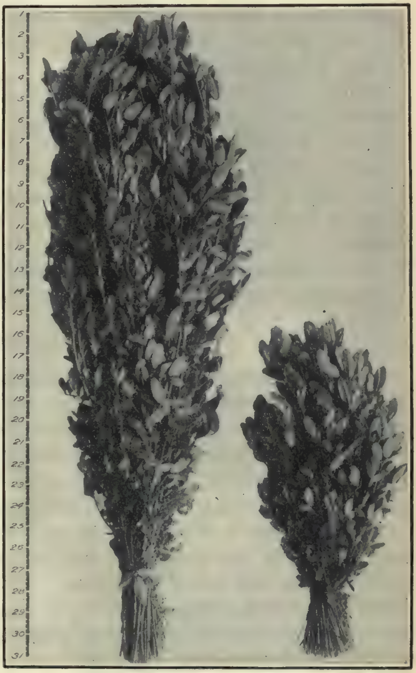

FIG. 9.—White sweet clover at Arlington, Va., showing the effect of inoculation upon their growth. The plants at the left represent the average growth on the inoculated plats; those at the right the average growth on the plats not inoculated. The plats had been previously limed and were seeded on the same date.

INOCULATION.

Excepting soil acidity, lack of inoculation probably is responsible for more failures with sweet clover than any other one cause. When sweet-clover plants are not inoculated they must depend upon the available nitrogen in the soil for their supply, and as the crop is grown for the most part on soils low in nitrogen the plants can not be expected to make more than a small growth. (Fig. 9.)

Arny and Thatcher, at the Minnesota Agricultural Experiment Station, obtained 10 times as much dry matter in the tops and seven times as much in the roots of sweet-clover plants which had been grown on thoroughly inoculated soil as from plants which had been grown on soil not inoculated. Moreover, the plants grown on the inoculated soil contained 117 pounds more nitrogen to the acre than those grown on the uninoculated soil.

Experiments in many other sections of the country, and especially in the northeastern quarter of the United States, where but little sweet clover or alfalfa has thus far been grown, show that inoculation is very essential to success. Ordinarily it is not necessary to inoculate sweet clover when it is to be planted on land where alfalfa, bur clover, or black medic thrives, because the same strain of inoculating germs inoculates all of these plants. However, when this clover is to be planted on land where none of the plants inoculated by this strain of the organism have been grown, inoculation should be provided. In localities where sweet clover or other plants inoculated by the same strain of bacteria thrive, the early growth has at times been made much more vigorous by inoculating the soil or seed thoroughly.

It is not safe to assume that a certain piece of soil is inoculated because any one of the plants inoculated by the same strain of the organism is growing or has been grown on other fields in the same vicinity. Many fields have come under observation where sweet clover was a failure because the plants were not inoculated, when plats or fields of alfalfa growing near by were abundantly inoculated.

There are several methods of inoculating sweet clover, any one of which when properly applied should give good results.

THE SOIL-TRANSFER METHOD.

The soil-transfer method of inoculation consists in scattering over the field to be seeded 200 to 400 pounds to the acre of soil collected from sweet-clover, alfalfa, or bur-clover fields where the healthy plants show an abundance of tubercles on the roots. It is strongly recommended that this soil be scattered on a cloudy day or in the early morning or in the evening and immediately harrowed or disked into the ground, as the sun's rays are very injurious to the inoculating germs. It is a good plan for the person scattering the soil to walk directly in front of the harrow. When this practice is followed little harm can be done by the light. To facilitate even scattering, the soil may be mixed thoroughly with two or three times its weight of other soil, preferably from the field where the sweet clover is to be sown. Soil used for inoculating sweet clover does not necessarily have to be scattered on the land just previous to sowing the seed. It may be scattered a few months or a year in advance of the time the sweet clover is to be seeded and be just as effective as if it were scattered at a later time. In general, where sweet clover is to be seeded in the spring on winter grain, the inoculation should be applied before the grain is sown.

Good success has been obtained by drying in a dark place soil containing the inoculating germs, sifting it, and running it through the fertilizer compartment of a grain drill. When this method is employed it is not necessary to use as much soil as when it is scattered broadcast.

A comparatively new method which has given successful results calls for dampening each bushel of seed and spreading it on a cloth, paper, or cement floor, where half a gallon of thoroughly inoculated soil from sweet-clover or alfalfa plants may be sifted over it. Some people prefer to add a trace of glue or sugar to the water, so that more of the soil will adhere to the seed, although some soil will remain on the seed if the glue or sugar is not used. When only this quantity of soil is used it should be collected from around the roots of sweet-clover plants which are abundantly inoculated. Such soil may be collected in the fall and kept until spring in a cool, dry, dark place with no injury to the inoculating organisms. Seed treated in this manner should be kept in the dark and should be sown as soon as possible after treating.

THE PURE-CULTURE METHOD.

The pure-culture method has the advantage of greater ease of transportation and freedom from danger of introducing harmful pests upon the farm. Inoculation by pure cultures may be carried out in either of two ways:

(1) A bottle of pure culture of the proper kind of bacteria is opened and the culture mixed with a convenient quantity of water; this diluted culture now is mixed thoroughly with a considerable quantity of soil, preferably from the field where the legume is to be sown; the treated soil is then distributed in the same manner as when inoculation is made by the soil-transfer method.

(2) A pure culture of the proper kind of bacteria should be applied to the seeds in such a way that they will all be moistened. The seed should then be permitted to dry in a shady or dark place and should be planted as soon as possible after it is dry. Drying may be facilitated by adding dry, sifted soil, preferably from the field where the seed is to be sown. Inoculating organisms very often die within a week after the seed is inoculated. It is highly desirable, therefore, that the inoculation be made the day the seed is sown. Inoculated seed never should be dried in the sun.

The question is often asked whether it is advisable to inoculate seed with the pure-culture method and sow it on honeycombed ground in the spring. No experiments have thus far been completed to determine the advisability of this procedure. Some inoculation would probably result from this practice, because the bacteria on that portion of the seed next to the ground would be protected from the sunlight and would in a short time under ordinary conditions be covered by the freezing and thawing of the soil. While it is hardly possible to obtain as complete inoculation by this practice as by other methods, it is to be preferred to no inoculation.

TREATMENT OF THE STAND.

The manner in which a stand of sweet clover is handled should depend somewhat upon the method and date of seeding and the purpose for which it is sown. Climatic conditions should also be taken into consideration and the handling of the crop governed accordingly.

TREATMENT THE FIRST SEASON.

The most serious objection to seeding sweet clover in the spring without a nurse crop is weeds. In many sections of the country weeds will take as much water from the soil and make as much or more shade than a crop of grain. In spite of the fact that sweet clover will withstand more adverse conditions than red clover or alfalfa, a heavy growth of weeds will greatly retard the growth of the plants and in some cases kill most of them. (Fig. 10.) On plats sown in April without a nurse crop at Arlington, Va., it was necessary to mow weeds five times during the summer of 1915 in order to keep them partly checked. Where it is necessary to mow a field so many times the plants are not only checked or killed, but as much time is required for this work as would be necessary to harvest a crop of grain. This trouble may be overcome in part by pasturing the sweet clover the first season, but even then during wet weather it may be necessary to cut the weeds at least once before the plants become well enough established to turn live stock on the field. The plants should at no time be clipped closer than 5 inches from the ground.

After a field of sweet clover has become well established, it may be pastured throughout the summer and fall. Close grazing should be avoided during the summer, or the plants may be killed, but they may be pastured fairly close to the ground in the autumn, as it does not appear as necessary to provide a winter covering as is the case with red clover. Close pasturing or clipping late in the fall has had a marked effect on the growth of the plants the following spring on some fields and no apparent effect on the stand and growth of the plants on other fields. A portion of a field in Livingston County, Ill., was clipped close to the ground in the late fall of 1915. On June 1, 1916, the stand was somewhat heavier on the unclipped part of the field. More noticeable than the thickness of the stand was the fact that the plants on the unclipped portion were 8 to 10 inches higher than those on the clipped area. It is reasonable to believe that plants going into the winter with no protection are more likely to be injured than those having some protection.

On the other hand, many fields in different parts of the country have been closely clipped or pastured in the late fall with no noticeable injury. Because of the value of the hay or pasturage in the late summer and autumn of the year of seeding, it is strongly recommended that the first year's growth be utilized. If the field be cut for hay it is well to leave a 4-inch or 5-inch stubble, as this will serve to catch drifting snow during the winter, thereby adding to the protection against winterkilling. If the field is not pastured the first season and weeds are not troublesome, a cutting of hay may be made when growth ceases in the fall.

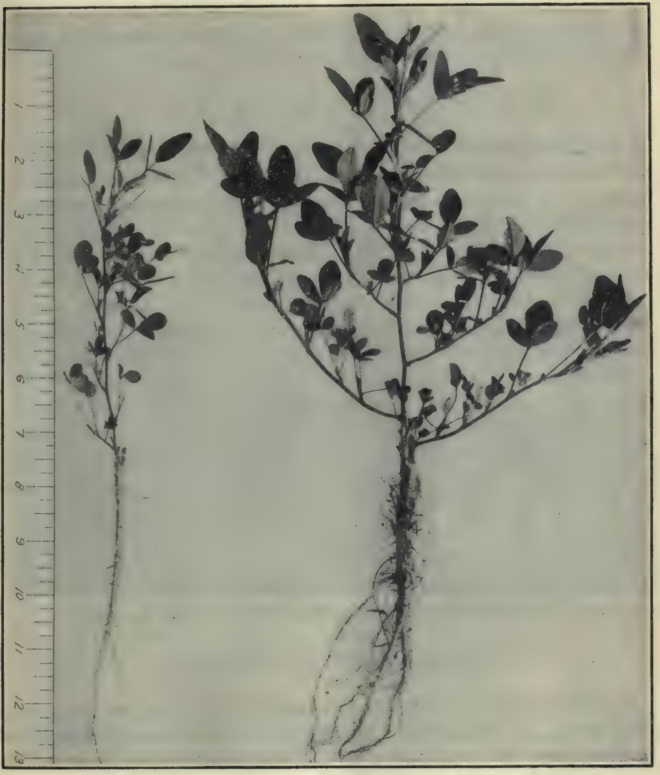

FIG. 10.—White sweet-clover plant (at the left), showing the effect of a heavy growth of weeds. Had the weeds not been present the plant at the left should have been larger than the one at the right, as the seed was sown two weeks earlier and the other conditions for growth were ideal. Four-fifths of the plants on the plat which had a heavy growth of weeds were entirely killed.

When sweet clover is seeded with grain, moisture conditions should serve to determine whether the grain should be permitted to ripen or be cut for hay. When untimely droughts appear the plants may be killed if the grain is not cut as early as possible.

In the South and in some sections of the Eastern and North-Central States where the soil contains an abundance of limestone and is well inoculated, a cutting of hay may usually be obtained after a grain crop has been harvested. In other sections of the North in only exceptionally favorable weather will more than pasturage be obtained after the grain is cut.

TREATMENT THE SECOND SEASON.

One of the special advantages of sweet clover is that it produces good pasturage somewhat earlier in the spring than most forage crops. In the North, with the exception of the extreme northern portion of the United States, it will furnish a cutting of hay in June or excellent pasturage until that time and a crop of hay or seed in late summer. In the South two cuttings of hay and a seed crop may be harvested. After maturing seed the plants die. It is a common practice in many sections to pasture the crop until about June 10, when the stock is removed and the plants are permitted to mature seed. If the plants have not been grazed closely they should be clipped at this time, so that the seed crop will ripen more evenly. Sweet clover may be pastured during the entire second season's growth, provided sufficient stock is kept on the field to prevent the growth from becoming woody. If the plants become coarse the pasture may be clipped, leaving an 8-inch stubble, so as to induce a new growth which will be more palatable. If it is desired to have the pasture reseed itself stock should be removed at least eight weeks before heavy frosts are expected, or only sufficient stock should be permitted to remain on the pasture to keep some of the plants in check.

SWEET CLOVER IN MIXTURES.

Very little sweet clover thus far has been grown in mixtures with other crops. A few farmers have sown red clover and sweet clover together, but such a mixture has no advantage over sweet clover seeded alone for hay, as sweet clover should be cut at least two weeks before the red clover is ready to harvest. Sweet clover is being seeded to some extent on native prairie sod in the Northwest, where it is claimed it adds greatly to the value of the native grasses for pasturage. A thin seeding of sweet clover is often desired in bluegrass pastures on this account. One of the best pastures in eastern Iowa consists of a mixture of bluegrass, timothy, and sweet clover. The Mississippi Agricultural Experiment Station recommends a mixture of Johnson grass and sweet clover. In this mixture the first cutting will consist of almost pure sweet clover, while the second and third cuttings will be a mixture of those plants. A number of southern farmers have had good success in seeding sweet clover on Bermuda-grass sod.

The New Jersey Agricultural Experiment Station has obtained excellent results from a mixture of Dwarf Essex rape and sweet clover, and also by the addition of soy beans to this mixture. It was found that by seeding 6 pounds of rape and 10 pounds of sweet clover per acre an abundance of nutritious pasturage was produced and that pigs preferred this mixture to alfalfa. When soy beans were added it was seeded at the rate of 1 bushel of soy beans, 6 pounds of Dwarf Essex rape, and 18 pounds of sweet clover. The soy beans were drilled by themselves, and the rape and sweet clover were mixed and seeded with a press drill. Brood sows made a gain of from three-fourths to 1 pound a day during July on this mixture without additional feed and gave unusual evidence of thrift and vigor.

FIG. 11.—A cornfield, showing the effect of fall and spring plowing in killing sweet clover that had made but one year's growth. The portion of the field at the left was plowed in the autumn, while that at the right was plowed the following spring, after the plants had started growth. The corn is 4 inches high.

ERADICATION OF SWEET CLOVER.

Some farmers hesitate to plant sweet clover on their farms for fear they will have difficulty in eradicating it when the fields are planted to other crops. The results obtained annually by hundreds of farmers are sufficient proof that there is no foundation for such fear; in fact, farmers are experiencing much difficulty in cutting the first crop the second season so high that the plants will not be killed. The new crop of sweet clover, unlike that of red clover and alfalfa, must come from the buds left on the stubble, so when the plants are cut below these buds they will be killed. As sweet clover is a biennial, the plants die as soon as the seed crop is produced.

When the first year's growth of sweet clover is to be turned under for green manure it is recommended that the field be plowed after the plants have made some growth the following spring rather than in the fall of the year of seeding. When the first year's growth is plowed under the same fall many of the plants will not be entirely covered, and these will make a vigorous growth the following spring. When the plowing is delayed until the plants have made some growth the following spring no trouble will be experienced in eradicating them. (Fig. 11.)

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THE SHEEP TICK
AND ITS ERADICATION BY DIPPING

MARION IMES
Zoological Division

FARMERS' BULLETIN 798
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
A. D. MELVIN, Chief

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THE SHEEP TICK, while not a true tick, is a blood-sucking parasite which infests sheep on both farms and ranges. It is widely prevalent and spreads rapidly, especially among the close-herded range flocks, where it may cause much damage and loss. The nature and habits of the tick are described, also methods of identifying it.

The only practicable way of destroying the pest is by dipping the sheep. Two dippings are necessary, about 24 days apart, as the first dipping may not destroy all the pupæ (eggs), and these may subsequently hatch a new brood.

Several kinds of dips are used successfully. Of the home-made dips the one found to be most efficacious is the lime-sulphur-arsenic dip. Full directions for making this dip are given in this bulletin. Methods of dipping large and small flocks are discussed, including plans of a wooden and a cement vat, showing details of construction.

THE SHEEP TICK AND ITS ERADICATION BY DIPPING.

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DISTRIBUTION AND ECONOMIC IMPORTANCE.

The sheep tick (*Melophagus ovinus*) is not a true tick but a wingless parasitic fly which passes the various stages of its life on the sheep. In many of the English-speaking countries it is known as the "ked" and is sometimes called the "louse fly" from its habit of living in the wool like a louse, but among the sheep growers of this country it is known as the sheep tick. It is widely distributed in many of the sheep-growing countries of the world, including the United States where it is known to occur in practically all of the States where sheep are kept. It is most prevalent, however, in the western range States where sheep are herded in large flocks. The northern two-thirds of the range country, or that part known as the Northwest, is the most heavily infested.

For a number of years it had been the custom in the majority of the principal sheep-growing States to dip the flocks regularly for scab. Such dipping evidently checked the spread of sheep ticks also, but as scab has been eradicated in many of the States compulsory general dipping for scab was discontinued in such areas, and especially in the Northwest. In the meantime the ticks spread rapidly and became prevalent in many of the flocks to such an extent that in some of the States compulsory general dipping was resumed in order to eradicate them. The sheep owners in some of the Southwestern States have continued to dip their flocks more or less regularly each season and consequently the ticks are not so plentiful in those areas. However, they are gaining a foothold in many of the flocks in this section, and conditions indicate that they may become a source of considerable loss if dipping is discontinued before they are eradicated.

Many of the farm flocks of the United States harbor sheep ticks and in some cases they are present in sufficient numbers to cause considerable damage to such flocks. This is especially true where open-fleece sheep are kept.

The sheep tick obtains its food by puncturing the skin of the sheep with its lance-like proboscis or sucking tube and feeding on the blood and lymph. The irritation thus caused is very great, especially in the case of lambs that are infested heavily, and while the quantity of blood drawn by one tick in 24 hours is small, the total amount taken by a large number of ticks is considerable and the drain constant. The irritation caused by the ticks makes the sheep restless so that they do not feed well, and in consequence, they do not grow and fatten as rapidly as when free from ticks. Thus a loss is caused by shrinkage in weight and a general unthrifty condition of infested flocks, with a consequent lowering of the vitality and a reduction in the resisting power of the animals. These conditions not only help to reduce the market value of the sheep but also tend to reduce wool growth, although being a bloodsucker, the tick does not feed on the yolk of the wool or directly injure the fibers to any great extent.

During the course of the investigations conducted by the Bureau of Animal Industry bearing on the problems of eradication, estimates of the average annual losses caused by sheep ticks were submitted by a large number of sheep owners in Utah. According to these estimates, the average annual losses are 25 cents per head for lambs and 20 cents per head for ewes in infested flocks. These figures are undoubtedly very conservative, as in estimating losses caused by parasites the indirect losses are seldom taken into consideration. Any factor operating to lower the vitality and resisting powers of domestic animals usually causes indirectly a considerable death loss during unfavorable seasons. The old saying, "Poverty breeds parasites," might with at least equal truth be read the opposite way, "Parasites breed poverty."

LIFE HISTORY.

The sheep tick, being a wingless fly, is in no way directly related to the true ticks. A true tick in the adult stage has 8 legs, while the so-called sheep tick has only 6 legs and in general form and structure is entirely different. (See fig. 1.)[1] Like other insects, sheep ticks vary in size, but the average length of adult females is about one-quarter of an inch. The life cycle of the sheep tick is divided into four natural stages or divisions, namely, the egg, the larva, the pupa, and the adult or sexually mature insect.

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[1] Figures 1 to 8 are from photographs by Dr. W. T. Huffman, and the picture on the title page is from a photograph by Dr. George A. Lipp.

The egg is not laid, but is retained in the body of the female, where it develops into a larva in about 7 days. At the time of birth the larva is covered with a soft white membrane, which turns brown and becomes a hard shell, called a puparium, in about 12 hours. (See fig. 2.) The term pupa applies to that stage in the life of the sheep tick from the time it is born until it hatches into a young tick. During this stage the pupa remains within its hard shell or puparium, which is attached to the wool fibers by a glue-like substance which dissolves readily in water. These shell-covered pupæ are commonly called eggs. In from 19 to 24 days from the time it is deposited the shell of the pupa is broken open at one end and the young tick emerges and becomes active in the fleece. The time between the depositing of the pupa and the emergence of the young tick is usually called the period of incubation, and its duration is influenced by the temperature. During warm weather the average period of incubation is about 19 days, while during cold weather it is about

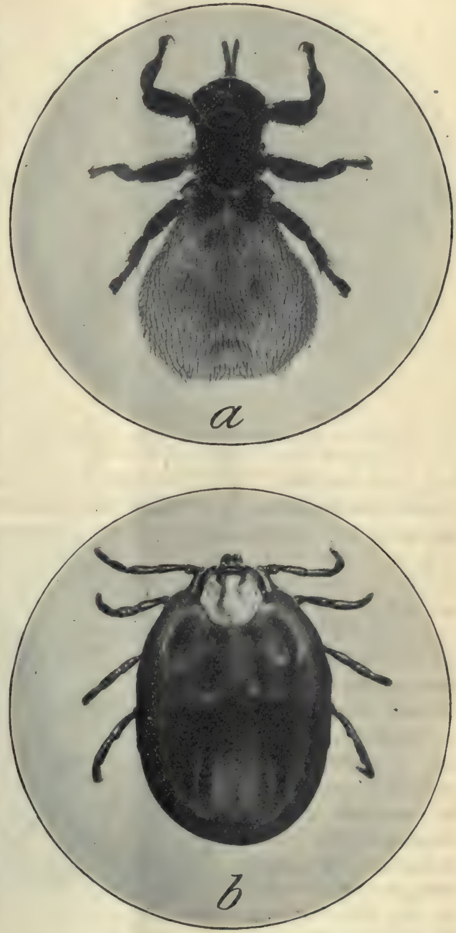

FIG. 1.—Comparison of form and structure of sheep tick and true tick. (*a*) Sheep tick (engorged female, enlarged); (*b*) true tick (engorged female, enlarged).

24 days, and in some cases longer. However, in practical operations under average conditions, 24 days has been assumed to be the longest period.

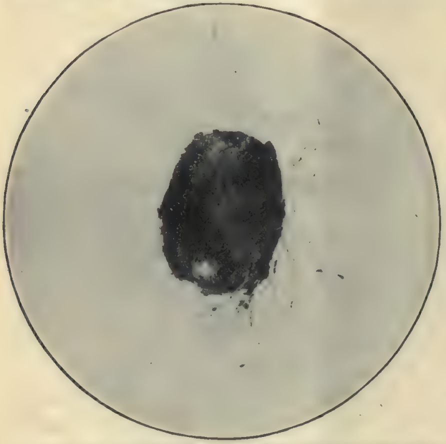

FIG. 2.—Pupa of sheep tick, commonly called the egg, taken from fleece of sheep; enlarged.

At the time the young tick emerges from the shell it is almost as large as a full-grown tick. (See figs. 3 and 4.) It develops very rapidly and reaches sexual maturity in 3 or 4 days. The female deposits her first pupa within 8 to 10 days after being fertilized.

The life history of the sheep tick, from the practical standpoint, may be summarized thus: Counting from the time when it emerges from the shell, the young tick deposits its first pupa or so-called egg in about 14 days. This pupa hatches into a young tick within 19 to 24 days. These two stages in the life history have an important bearing on the problem of eradication.

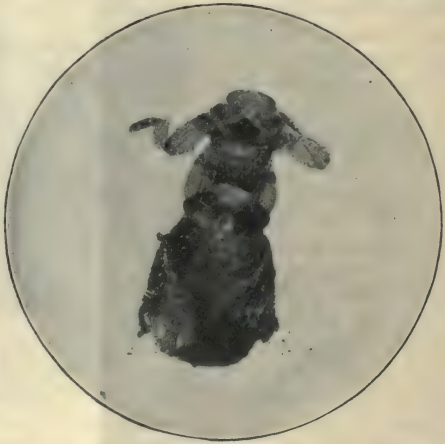

FIG. 3.—Young sheep tick emerging from the puparium; enlarged.

Dipping, if properly done, will kill all the ticks, but can not be depended upon to destroy all the pupæ. Some of the pupæ that were in the wool at the time of the first dipping will hatch, forming a new generation of ticks. This new generation must be destroyed by a second dipping before they have had time to develop and deposit pupæ. On the other hand, the second dipping should not be done before all the pupæ which were in the wool at the time of the first dipping have had time to hatch, otherwise they may hatch after the second dipping and reinfest the flock. Consequently, it is important to allow a proper interval of time between the first and second dippings if the results are to be successful. The first dipping probably destroys many of the pupæ that are less than 4 days old, and the dip remaining in the wool has a tendency to prevent the development of young ticks and probably kills many of them. Under average conditions during early fall dipping, 24 days should elapse between the first and the second dipping.

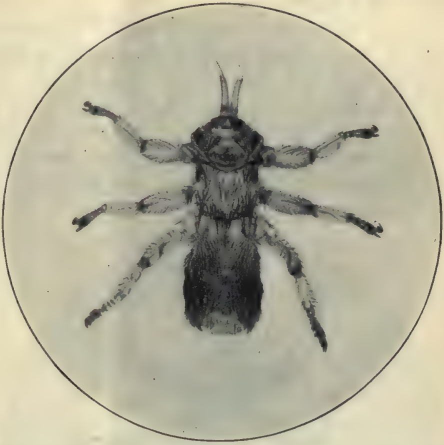

FIG. 4.—Young sheep tick just after emerging from the puparium; enlarged.

NATURE AND HABITS.

True ticks, such, for example, as the Texas-fever tick, do not pass their entire life on the animal which they infest, but always drop to the ground to lay their eggs. The life history of the sheep tick is more simple. It does not drop off the sheep to lay eggs, but deposits its pupæ in the fleece. Each female deposits an average of from 12 to 15 pupæ during her lifetime, one being laid about every 7 or 8 days. These pupæ, or so-called eggs, are attached to

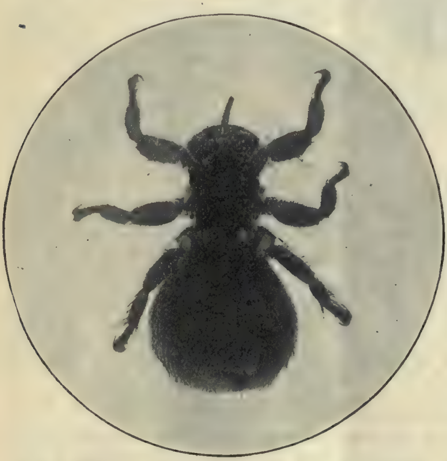

FIG. 5.—Mature male sheep tick, back view; enlarged.

the wool fibers, usually from one-half inch to an inch from the skin. Consequently when the sheep are shorn the majority of the eggs are removed with the fleece.

Sheep ticks when feeding attach themselves temporarily to the skin of the sheep by burying their sucking tubes in the tissues; when not feeding they move about in the fleece. During cold, inclement weather they remain deep in the fleece close to the skin for shelter and warmth, but when the days are warm they are found near the surface and often can be seen in great numbers crawling over the tips of the wool. Sometimes they are dislodged from this position and thus temporarily infest trails, pastures, corrals, bed grounds, and premises. When dislodged from a sheep they crawl upon another at the first opportunity.

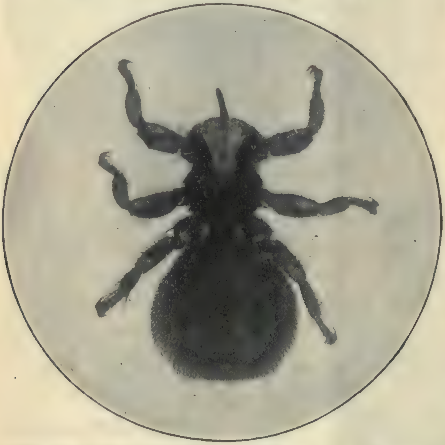

FIG. 6.—Mature male sheep tick, front view; enlarged.

The sheep tick does not transmit any known disease to the sheep, but it harbors a very small one-celled animal organism, related to forms which are transmitted by insects to various animals, including man, and which cause serious diseases.

Open-fleece sheep, such as the coarse-wool and medium-wool breeds, are subject to ravages by the tick. The fine-wool sheep usually are not affected to any great extent, as the parasites do not seem to be adapted to existence in the greasy, tight fleeces of such breeds. When the flock is heavily infested the ticks may be found on any part of the body, but they usually select locations where the wool is thin and occur in greatest numbers on those parts where they are protected from the efforts of the sheep to dislodge them. The neck, breast, shoulders, belly, and thighs are the favorite locations.

Many of the ticks are removed with the fleeces at the time of shearing, especially if machine shearing is practiced. The freshly shorn sheep offers very little protection for the ticks, and consequently, during the shearing season, the ticks migrate to the lambs in large numbers. The lambs of the flock suffer most from the ravages of this pest, and if they become heavily infested receive a setback at an important period in their development, thus causing considerable financial loss to the owner.

SPREAD.

Although sheep ticks do not seem to possess the instinct of migration to any great extent, nevertheless, once introduced into a flock, they spread rapidly until the entire flock is infested. As range sheep are usually close herded, crowded into corrals, and come into close contact on the bed grounds, the ticks pass readily from one animal to another. On farms, where the sheep are not close herded but graze in fenced inclosures, the conditions are not so favorable to rapid spreading; but during cold weather, when such sheep are placed in corrals, sheds, or barns, in close contact, every member of the flock as well as the premises will almost certainly become infested if there are ticks on any of the sheep.

While sheep ticks will not propagate or even live for any considerable time on other animals than sheep,[1] they may be harbored temporarily by dogs or other animals which have come in close contact with an infested herd. Men working among infested sheep may carry the parasites on their clothing and thus be the means of introducing them into clean flocks. If separated from the sheep the ticks do not live longer than about 4 days, as a rule, and it might be assumed that places from which all sheep had been removed would become free from sheep ticks within a very few days. However, the survival of dislodged ticks is not the only factor influencing the length of time premises may remain infested after the removal of infested sheep. Tags of wool to which pupæ are attached may be pulled out by bushes, fences, etc., or by the sheep themselves. If the weather is warm and other conditions favorable these pupæ will hatch and infest the premises.

Under ordinary conditions the period of incubation is from 19 to 24 days and in some cases longer, the length of the period being influenced by temperature and other factors. Laboratory experiments have indicated that the incubation period of pupæ removed from sheep may be as long as 46 days. Infested sheep, in their efforts to obtain relief from the irritation and itching, may dislodge some of the ticks and eggs. The ticks will die in a few days, but if conditions are favorable the pupæ or eggs will retain their vitality and hatch in due time. The pupæ dislodged from the sheep during cold weather or when the nights are frosty will not hatch, but will be destroyed. It seems reasonably certain that freezing temperature will destroy the vitality of the pupæ. These facts have an important bearing on the problem of eradication. Premises or places occupied by ticky sheep may become infested, and if conditions are favorable for the development of the pupæ they may remain infested for a period of from 45 to 50 days from the time ticky sheep were removed. A seemingly safe basis of practice during warm weather would be to consider all premises occupied by ticky sheep as infested for a period of 60 days from the date of infestation. During cold weather, when the temperature drops to freezing at any period during the day or night, infested premises probably would become free from infestation within a day or two, except in places well protected from the cold, such as sheds and stables.

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[1] Experimental data seem to indicate that sheep ticks may live and propagate on goats. Dr. E. R. McClure placed 12 ticks on an Angora goat and held the goat under observation for 60 days. The ticks lived and propagated during this period, at the end of which time the goat was returned to the flock and observations were discontinued.

During warm weather infested corrals or inclosures should not be used for clean sheep. If it is necessary to use such corrals they should be cleaned and disinfected by removing all litter and manure, cleaning down to a smooth surface, after which the floors and sides should be sprayed with a good disinfectant. The coal-tar-creosote dips diluted to double the strength recommended for dipping are suitable for this purpose. The cleaning should be done carefully in order that all pupæ may be removed with the litter, as the disinfectant probably will not destroy the vitality of the pupæ. All litter and manure from infested premises should be spread on the ground and plowed under or disposed of in such manner that sheep can not come in contact with it for at least 60 days. An economical and effective method of disinfecting stone or wire fence corrals is to scatter straw or brush over the surface of the ground and burn it. If the brush or straw is dry so it will burn readily sufficient heat will be produced to destroy the parasites.

DETECTING TICKS IN THE FLOCK.

When sheep are heavily infested with ticks they bite and scratch and rub against any available object, including other members of the flock. The natural position of the wool is disturbed by these efforts to obtain relief from the intense itching; more or less wool is pulled out, and the fleece may have a ragged appearance. (See fig. 7.)

If sheep ticks are causing the trouble, they may be found by parting the wool over the neck, breast, shoulders, belly, and thighs. They are large enough to be seen readily and are of a brownish color. On warm days they often may be observed crawling over the tips of the wool. If ticks are present pupæ usually will be found attached to the wool fibers. These are seen easily with the naked eye, being about one-eighth of an inch in length. Their color varies from yellowish white to dark brown, and the shell is glossy and firm. (See fig. 8.)

Any condition which causes the sheep to bite and scratch themselves may be mistaken temporarily for ticks. In every instance close examination should be made and the cause definitely learned. It should be remembered, however, that the presence of ticks does not exclude other possible causes of the irritation, such as scab, lice, common ticks, bearded seeds, thorns, etc.

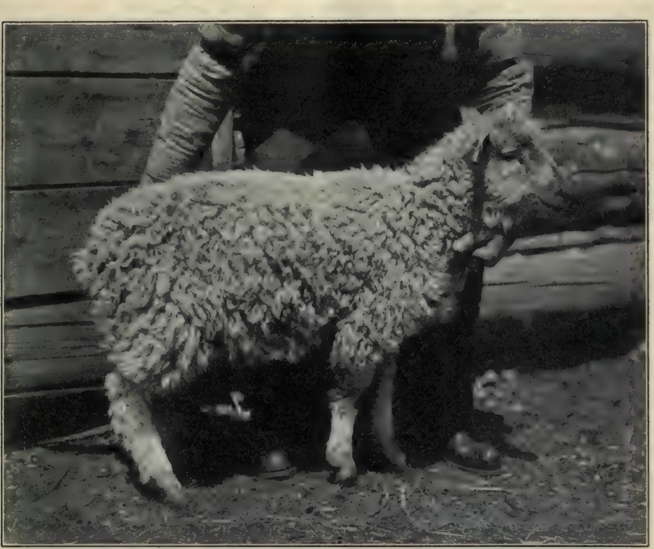

FIG. 7.—Lamb grossly infested with sheep ticks, showing roughened condition of fleece.

ERADICATING THE TICKS BY DIPPING.

Dipping consists of immersing the animals in a medicated liquid that will kill the parasites, and is the only practicable method known for eradicating sheep ticks. The process of dipping is shown in the illustration on the title page. In order that the medicated liquid or dip may exert its killing powers it is necessary that it come in direct contact with the tissues of the parasite. There are three methods by which the dip may enter the organism of the tick; first, ingestion, by way of the mouth parts, through the digestive organs; second, respiration, by way of the stigmata or breathing pores, through the respiratory organs; third, absorption, through the skin by a process of osmosis. The nonvolatile dips, such as the arsenic group, are probably taken in largely by ingestion and to a less extent by absorption, and kill through cumulative action of the poison. The nicotin dips are probably taken in mainly by absorption and to a less extent by ingestion and respiration. The coal-tar-creosote and cresylic-acid dips give off gases and are taken in mainly by respiration and possibly to a less extent by absorption. It is seemingly not a mere question of bringing the parasite into temporary contact with the dip, as the period of time during which the poison exerts its action is an important factor. Very few of the known dips will kill the parasite immediately; therefore the length of time the sheep are held in the vat is not the sole determining factor, provided they are held in the dip a sufficient length of time to saturate the fleece. The length of the wool, the quantity of dip retained in the fleece, the length of time that the dip remains active in the wool, and the nature

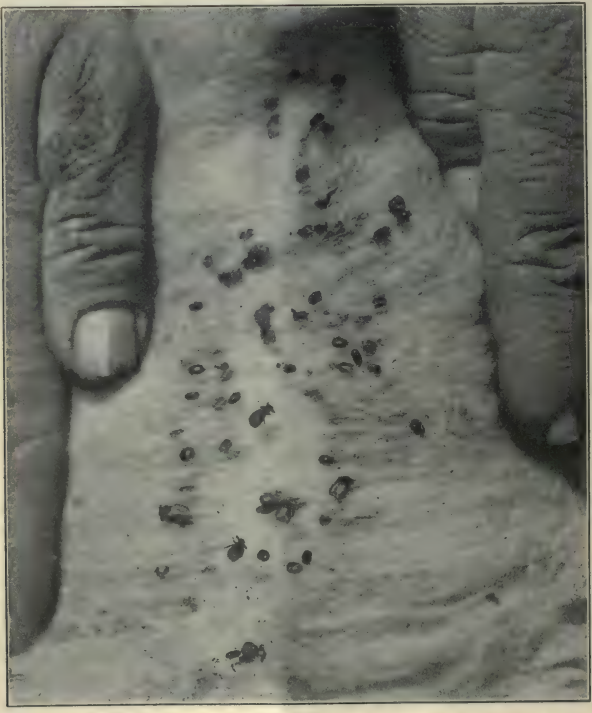

FIG. 8.—Close view of portion of neck of lamb shown in figure 7, showing ticks and pupæ in wool.

of the active principle, all have an important bearing on the results. Other factors being equal, the dip that remains longest in the wool and retains its killing power for the longest period is most desirable, not only for destroying the parasites on the animal but also for preventing reinfestation.

In dipping sheep for ticks the entire flock, together with all goats, dogs, or other animals which may have been with the sheep, should be dipped regardless of the number showing infestation. The fleece should be saturated thoroughly, but as there are no crusts or scabs to be penetrated, it is not necessary to hold the animals in the vat longer than about 1 minute. The head of each animal should be submerged at least once and care taken that every part of the fleece is wet. As only coarse-wool and medium-wool sheep usually become infested heavily, and as such fleeces are penetrated easily by the dip, it is not considered necessary to maintain the dip at a high temperature. However, it should not be cold enough to chill the animals; the range should be between a minimum of 65° F. and a maximum of 95° F. The temperature of the dip should be ascertained accurately by using a thermometer. If a proprietary dip is used the printed instructions on the label of the container should be followed both as to the time the animals are to be held in the dip and the temperature at which the dip is to be used.

The season best suited for dipping to eradicate ticks depends upon the altitude, the climatic conditions, and the methods of handling the sheep. In those sections where spring shearing is practiced, July and August are considered the best months for dipping. If the lambs become heavily infested shortly after shearing, which often occurs, the flock should be dipped as soon as the shear cuts heal. One objection to dipping too soon after shearing is that the wool is short and the fleece will not retain much of the dip. For this reason fall dipping probably would prove more effective than summer dipping in eradicating ticks. It is advisable, however, to dip at about the same time that the neighboring flocks are dipped in order to lessen the chances of reinfesting the neighborhood.

If the dipping is to be successful, it is necessary to give close attention to the details and to see that the work is performed carefully and thoroughly. Sheep should not be dipped immediately after shearing; a period of at least 10 days should elapse between shearing and dipping, in order that the shear cuts may heal. It is dangerous to dip sheep in some of the dipping preparations if there are any fresh wounds on the animals; consequently, dogs that bite the sheep should not be allowed in the dipping corrals. The chutes, pens, and dipping vat should be examined closely for nails, broken boards, or any object that may puncture or wound the skin of the sheep. Animals having fresh wounds when dipped in some of the dips usually develop a condition commonly known as "blood poisoning," and the mortality from this cause is high. After the wounds have granulated or healing is well started there is little or no danger from this source. Rough handling of the sheep at the time of dipping results in more harm and damage to the flock than is caused by the dip. When sheep are placed in the dipping vat by hand, the men handling them should be instructed to do so carefully. They should not be allowed to catch the sheep by the ears; this is sometimes done, and has resulted in breaking or bruising the skin, causing the heads to swell after dipping, and resulting in considerable death loss.

Ewes and lambs should not be dipped together; if put into the vat at the same time the danger of drowning some of the lambs is much greater than when they are dipped separately. The lambs should be "cut out" and dipped separately, and they need not be held in the swim as long as the older sheep. It has been stated that the ewe recognizes her lamb more readily when they are dipped together; this, however, is probably not correct. A ewe recognizes her lamb by smell and not by sight, consequently after the flock has been dipped and the ewes and lambs have been turned in together there is considerable commotion for a time, as the ewes fail temporarily to recognize their offspring. However, the members of the flock will adjust matters for themselves, and, as a rule, practically every lamb will be recognized by a mother. It often happens that an undipped sheep will jump out of the pens and get in with those that have been dipped. This should be carefully guarded against and all such sheep dipped before the flock leaves the vat.

Prior to bringing the sheep to the vat for dipping they should be watered and fed so as not to be thirsty or hungry at the time of dipping, although they will probably stand the effects of dipping better if not too full of feed and water at the time dipped. If they are watered and fed 3 to 6 hours before dipping they are likely to be in the best condition for the operation. When the weather is cold or stormy dipping operations should be commenced early in the morning and finished for the day in time to give the last sheep dipped opportunity to dry off before night. During winter weather dipping for the day should be finished by noon, so that the flock may have time to dry off and fill up with feed before night, as a sheep with a full stomach will withstand much cold and hardship. If these precautions are observed sheep may be dipped with reasonable safety during cold weather.

Bucks should be dipped separately from ewes and lambs. They should not be driven fast and then put into the vat before resting and cooling off. As they succumb very easily in the vat, it is necessary to give them careful attention. At the large vats the buck herds usually are dipped first, while the vat is full, so as to afford them more swimming room.

DIRECTIONS FOR DIPPING.

The quantity of dip in the bath should be sufficient to submerge the sheep completely; that is, the depth of the dipping fluid in the vat should be not less than 40 to 48 inches, depending on the size of the sheep. The quantity of fluid necessary to fill the vat to the required depth should be ascertained before it is prepared. Freshly shorn sheep and short-wool lambs will carry out on an average from 1 to 2 quarts of dip, depending on the size of the sheep and the length and grade of wool, while full-fleeced, fine-wool sheep will carry out and retain in the fleece as much as 2 gallons. At late fall dipping the average medium-wool sheep will retain in the fleece about 1 gallon of dip. In estimating the quantity of dip required, these facts should be taken into consideration. After computing the quantity of dip required to charge the vat, the average quantity which each sheep will carry out should be estimated; this should be multiplied by the number of sheep to be dipped, and the product so obtained added to the quantity required to fill the vat. If the vat and draining pens are water-tight, so that no dip is lost through them, the total as given above should show the approximate number of gallons of dip required to complete the work.

After the vat is filled to the required capacity the contents should be well mixed by stirring, in order that the temperature may be uniform throughout. A good method of stirring the dip in large vats is to take a 5-gallon pail or dip container, punch holes near the top, insert a wire for a bail, allow the can to fill and partially sink, then drag it with a dipping fork rapidly from one end of the vat to the other, and repeat the process until the temperature is uniform, as shown by taking it at several points in the vat. Stirring plungers are useful implements, and, as they are easily made, one or more should be provided at every vat. They are used in a manner similar to the movement of the dasher of an old-fashioned hand churn. The plunger is pushed to the bottom of the vat and raised rapidly, the process being repeated as the operator moves slowly along the vat. The style shown in figure 9 is the one most commonly used.

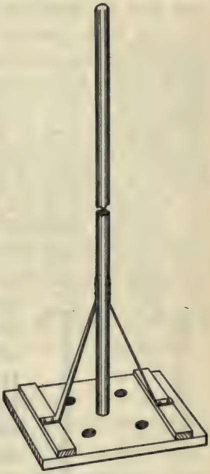

FIG. 9.—Stirring plunger for mixing liquids in the vat.

The dip should be changed as soon as it becomes filthy, regardless of the number of sheep that may have been dipped in it. In emptying the vat the entire contents should be removed, including all sediment and foreign matter. After the liquid portion has been dipped out or drained off, the sediment and dirt at the bottom should all be removed and the bottom cleaned by sweeping or scraping with a hoe or spade. After lime-sulphur-arsenic dip has been mixed to the proper strength for dipping and used in the vat, it should not be used again after it is 10 days old. This is a safe rule to follow with any of the sheep dips, as losses often occur from dipping in old or stale dips.

The drowning of sheep in the vat can be avoided by proper care. Men with dipping forks should be stationed along the vat on both sides to attend the sheep and prevent accidents. When the vat becomes filled with sheep their progress is retarded and they frequently attempt to raise themselves out of the dip by placing their forefeet on the back of the sheep in front. The men along the vat should prevent this by keeping the sheep properly arranged in the vat. The dipping forks should be used to keep all of the sheep's body submerged except its head while it is passing through the vat; this can be done by placing the dipping fork over the shoulders of the sheep and gently but firmly pushing it under the dip. The animal will raise its nose so that the neck and part of the head can be submerged without danger of strangling. Old ewes that have been dipped a number of times are sometimes difficult to handle, both in the chutes and in the dip. They will often lie on their sides in the vat, bracing themselves with their feet against one side and their backs against the other. When pushed under they will make efforts to regain this position and may strangle. Sheep that are affected by eating loco weed often drown in the vat unless they are piloted through. When strangling occurs the sheep should be taken from the vat. If it does not get upon its feet, pull the tongue forward, dash cold water over the head and body, and if necessary, induce artificial respiration. When it has regained sufficient strength, and if it has not been in the dip long enough, the animal should be returned to the pens and piloted through the vat again.

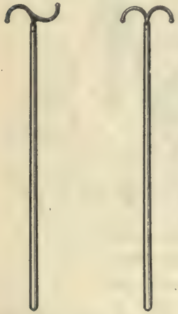

FIG. 10.—Two styles of dipping forks.

DIPPING FORKS.

In using large vats dipping forks are necessary for the efficient handling of the sheep and should be provided as a part of the equipment at every plant. Several different styles are made, but the two shown in figure 10 are the ones commonly used. The one with both hooks turned upward seems to have the preference for the reason that when it is in use either side may be hooked under the neck of the sheep for raising the head in case of strangling. The handles should be strong and from 5 to 6 feet long. The hooks should be made of half-inch round iron and firmly held in the handle by an iron ferrule. These forks can be bought ready-made or may be made by any blacksmith.

EXPENSE OF DIPPING.

The cost of dipping naturally varies in different sections; it also varies in the same section, depending on the number of sheep to be dipped, the location relative to the necessary supplies, and the facilities available for the work. The labor, fuel, and cost of materials are the three principal items of expense. In the sheep-growing sections of the West the average cost of dipping sheep varies from 2 to 3½ cents a head for each dipping.

WATER FOR DIPPING PURPOSES.

Water is so good a solvent that it dissolves and holds in solution large quantities of the various mineral salts. Waters containing such salts are commonly spoken of as being "brackish," "hard," or "alkali," depending upon the amount and character of the mineral matter contained. Much of the water on the semiarid ranges of the West is hard or alkaline and not suitable for diluting all kinds of dips. The thickly settled farming communities, being located in areas of greater rainfall, do not experience so much difficulty in finding a supply of reasonably good water. However, hard or alkaline waters are found more or less frequently in all parts of the United States, and where it is possible to do so their use for dipping purposes should be avoided for two reasons: First, to lessen the possibility of injury to animals; second, to increase the wetting powers of the dip and consequently the curative effects.

The wetting power of a dip is influenced by several factors, but observations indicate that when soft water is used for diluting dips the fluid has greater wetting power than when some of the hard waters are used. The term "beading" is commonly used in connection with dips of low wetting power. Such dips have a tendency to form in small bead-like drops over the wool instead of spreading in a film around each wool fiber and becoming evenly distributed over the entire exposed surface. By increasing the wetting power of the dipping fluid its efficiency is enhanced, because the active principle is more evenly distributed and all exposed parts receive the maximum possible wetting. Experience has demonstrated that good dips sometimes are rendered ineffective by being diluted with alkaline water.

Before diluting coal-tar-creosote or cresol dips with hard or alkaline water, a test should be made to determine whether a separation occurs in such water. In a clean bottle or jar of clear glass place a measured quantity of dip, and pour in, with thorough mixing, the desired quantity of the water, preferably warm, which should be added in approximately the proportion to be used in dipping. If after standing for one hour an oily layer or mass of globules appears either at the top or at the bottom of the liquid, the dip should not be used with that kind of water.

Sheep dips are most effective when used with soft water. If it is necessary to use alkaline water for diluting such dips, the water may be "broken" by using sal soda in the proportion of from 1 to 4 pounds for each 100 gallons of water, depending upon the "hardness" of the water. Where the water intended for dipping purposes is very impure the owner should have it analyzed and obtain the advice of a competent chemist on methods of correcting the water to render it suitable for diluting the dip he proposes to use.

KINDS OF DIPS.

In choosing a dip for sheep ticks the conditions under which it is to be used should be considered. A dip that might be best under one set of conditions is not necessarily so under all conditions. The nature of the dip and its effect on the animals when used with the water available at the dipping plant should be considered. If the dipping plant is not supplied with soft water the dip that works best in the water available should be selected. Dips deteriorate by use; that is, after a number of sheep have passed through the vat the active principle of the dip falls below the standard required for effective work. For example, during investigations in the Bureau of Animal Industry 35 lambs in 4 groups were dipped in a vat containing 60 gallons of diluted cresol U. S. P., 1 part to 100 parts of water. Samples were taken before and after dipping each group. These samples were analyzed, with the following results:

	Per cent cresylic acid.
No. 1, taken before any lambs were dipped	0.45
No. 2, taken after 9 lambs were dipped	0.34
No. 3, taken after 18 lambs were dipped	0.26
No. 4, taken after 27 lambs were dipped	0.18
No. 5, taken after 35 lambs were dipped	0.12

The difficulty has been overcome for some of the dips, and the Bureau of Animal Industry now supplies its inspectors with portable testing outfits for testing the dip at the vat. The only dips for which portable testing outfits are available at present are the arsenic, the nicotin, and the lime-sulphur.

Certain groups of ready-prepared dips are efficacious and have been used by flock owners with a fair degree of success. Among these may be mentioned the coal-tar-creosote, the cresol, and the nicotin dips. The only homemade dip which has proved efficacious is the lime-sulphur-arsenic dip. This dip probably will eradicate sheep ticks with one dipping when all conditions are favorable, but one dipping can not be depended upon in practical operations. It will undoubtedly eradicate ticks if the flock is given two dippings, and it has the advantage that it may be used in almost any of the hard waters without injury to the animals from that cause. Its disadvantages are that there is no test by which the rate of deterioration may be determined in the field and that it is more difficult to prepare than some of the other dips. None of the dips tried in the bureau's investigations can be depended upon to eradicate sheep ticks with one dipping.

COAL-TAR-CREOSOTE DIPS.

The coal-tar-creosote dips are sold under a large number of trade names. They are made from coal-tar derivatives and the principal ingredient is so-called creosote oil, which is made soluble in or miscible with water by means of soap. When diluted with suitable water they are very efficacious in eradicating sheep ticks from a flock if two dippings are given with an interval of 24 to 28 days between dippings. There is no field test for determining the deterioration of these dips, and consequently in replenishing the dip the percentage of active principle in the vat is largely a matter of guesswork.

These dips should contain, when diluted ready for use, not less than 1 per cent by weight of coal-tar oils and cresylic acid. In no case should the diluted dip contain more than four-tenths of 1 per cent nor less than one-tenth of 1 per cent of cresylic acid; but when the proportion of cresylic acid falls below two-tenths of 1 per cent the coal-tar oils should be increased sufficiently to bring the total of the tar oils and the cresylic acid in the diluted dip up to 1.2 per cent by weight.

In the undiluted coal-tar-creosote dips, especially in cold weather, a separation of naphthalene and other constituents of the dip may occur. Care should therefore be taken to see that the dip is homogeneous in character before using any portion of it.

CRESOL DIPS.

The cresol dips are sold under various trade names, and consist of a mixture of cresylic acid with soap. The term cresylic acid as used in this connection covers those cresols and other phenols derived from coal tar, none of which boil below 185° C. (365° F.) nor above 250° C. (482° F.). When diluted ready for use a cresol dip should contain one-half of 1 per cent of cresylic acid. As there is no field test available for cresol dips, the rate of deterioration can not be determined at the vat, and consequently after a few sheep have been dipped there is no method known for keeping constant the percentage of cresylic acid in the used dip.

When used with suitable water these dips are very efficacious in eradicating sheep ticks, if the flock is given two dippings 24 to 28 days apart.

Coal-tar-creosote and cresol dips should always be tested on a small scale, as outlined on page 17, to avoid injury to the sheep as far as possible. However, death losses may occur even when there is no apparent separation in the dips when tested under this method. Special care in this connection is necessary where hard water is used.

NICOTIN DIPS.

The nicotin dips are sold under various trade names, and the flock owners are more or less familiar with them from use in dipping for scabies. When used in seven-hundredths of 1 per cent solution they will eradicate sheep ticks, if two dippings are given with an interval of from 24 to 28 days between dippings. A field test has been designed by one of the large manufacturers of nicotin dips so the percentage of nicotin in the dip may be ascertained at the vat side at any time. These dips should be used in accordance with the instructions printed on the label of the container.

THE LIME-SULPHUR-ARSENIC DIP.

The lime-sulphur-arsenic dip is made by mixing standard strength lime-sulphur dip with one-half standard strength arsenical dip. Directions for making lime-sulphur dip and the arsenical dip and mixing the two to form a dip for sheep ticks are as follows:

The lime-sulphur dip is made in the proportion of 8 pounds of unslaked lime (or 11 pounds of commercial hydrated lime, not air-slaked) and 24 pounds of flowers of sulphur or sulphur flour to 100 gallons of water. Place the lime in a water-tight, shallow box and add sufficient water to form a thin paste. Sift the sulphur into this and mix well until a paste of about the consistency of mortar is formed, adding water as required. Place this lime-sulphur paste in 30 gallons of boiling water and boil for 1 hour, adding water from time to time to maintain the quantity at 30 gallons or in that proportion. During the boiling process the mixture in the boiling tank should be stirred well to prevent the paste from settling and caking on the bottom of the tank; the boiling process should be continued until all sulphur disappears from the surface. A large mortar hoe is a good implement with which to stir the boiling mixture. The lime and sulphur should both be weighed; do not trust to measuring them in a pail or guessing at the weight. It sometimes happens that the sulphur is not all "cut" or dissolved; this is especially true if the lime is not of first-class quality. Small quantities of extra lime may be added if during the cooking it is noted that the sulphur is not being "cut" properly. As an excess of lime in the dip will tend to injure the sheep and the wool, no more lime should be added than is necessary to cut the sulphur. After the mixture has been boiled for 1 hour the liquid should be of a chocolate or dark amber color.

The contents of the boiling tank should be drawn off or dipped out and placed in the settling tank and allowed to stand until all sediment has settled to the bottom and the liquid is clear. The use of some sort of settling tank provided with a bunghole is an absolute necessity, unless the boiler is so arranged that it may be used for both boiling and settling. An ordinary water-tight barrel will answer very well for a settling tank at small vats. All settling tanks of every nature should have an outlet at least 4 inches from the bottom, in order that the clear liquid may be drawn off without becoming mixed with any of the sediment (see fig. 11). Drawing off the liquid as above indicated has an advantage over dipping it out, for the reason that in the latter case the liquid is stirred more or less and mixed with the sediment. The prime object is to get the clear liquid without any sediment. The sediment should under no circumstances be allowed in the dipping vat, as it will injure the wool and the eyes of the sheep.

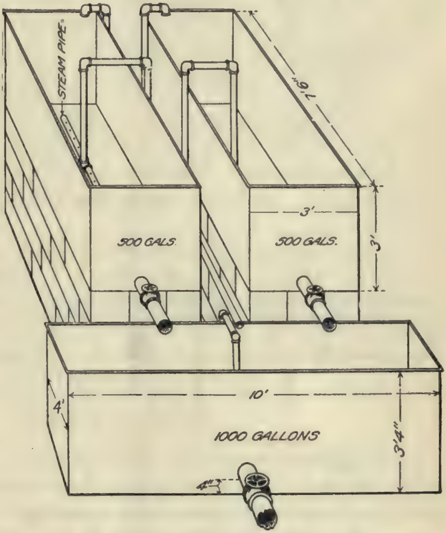

Fig. 11.—Cooking and settling tanks.

When the sediment has fully settled, draw off the clear liquid into the dipping vat and add warm water sufficient to make a total of 100 gallons of dip. When mixed and cooked as above specified the concentrate is three and one-third times the strength required for the dip in the vat, so that to every 30 gallons of such concentrate 70 gallons of warm water should be added to make a dip of the required strength.

In preparing lime-sulphur dip in large quantities, several hundred gallons of concentrate are often made at one time in a single large cooking tank. The quantity made at one boiling is limited only by the facilities at hand. If the boiling tank is of sufficient capacity enough lime-sulphur paste should be cooked at one time to dip the flock. The quantity of mixture in the cooking tank may be varied at will, but the proportions of the various ingredients should not be altered.

To each 500 gallons of lime-sulphur solution prepared and diluted as above directed add 4 pounds of arsenic[1] and 12 pounds of sal soda made into a solution as follows: Put 12 gallons of water in a kettle or tank, heat to boiling, and add 12 pounds of sal soda; when this has been dissolved add 4 pounds of powdered white arsenic, then boil and stir for 15 minutes or longer, until the white arsenic has entirely disappeared. The quantity of arsenical solution prepared at any one time is limited only by the capacity of the kettle or tank, but the proportions of the ingredients should not be altered. The arsenical solution should be added to the diluted lime-sulphur solution in the vat. When the arsenical solution is added a yellow-colored flocculent precipitate is formed which remains in suspension. The liquid in the vat should be well stirred before dipping operations are commenced. This dip can be used in any kind of water without injury from the water, but there is no field test for its strength.

It should be remembered that this dip is poisonous, and due precaution should be taken in handling and using it. The sheep should be held in the draining pens and holding corrals until all surplus liquid has drained from the fleeces. When the vat is emptied the dip should be disposed of in such manner that the animals may not have access to it. Preferably it should be run into an inclosed pit.

INJURY FROM DIPPING.

Dipping often results in a slight setback to the sheep. There may be a temporary shrinkage in weight or constitutional disturbances, or both. Various factors operate to produce these conditions. They may occur with any of the standard dips, but should not always be attributed to the effects of the dip alone. The age and physical condition of the sheep, the method of handling the flock at the vat as well as before and after dipping, the character of the water used, the method of preparing the dip, and various other factors should be considered before placing the blame on the dip. Young animals in a thriving condition recuperate very rapidly from any temporary ill effects; while old, weak, or emaciated animals succumb very readily and regain lost weight slowly. Injury caused by dipping is more likely to result from improper methods of dipping and handling than from the direct effects of the dip. Rough handling of sheep in the corrals and legging pens; dipping the flock immediately after a long, hard drive before they have rested and cooled off; dipping late in the afternoon when the nights are cold; keeping the sheep without feed and water for long periods before and after dipping; using dogs in the corral; and fighting stubborn sheep to get them into the chutes, are some of the contributing causes of injury. However, some of the dips if used in unsuitable water may cause injury, and any of them when used too strong will injure the sheep.

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[1] Farmers' Bulletin 603 contains directions for making arsenical dip.

The question often arises as to the proper age at which lambs should be dipped to get the best results and cause the least damage. It is perfectly safe to dip the flock when the lambs are not less than 1 month old, provided the lambs are dodged out and dipped separately. Any slight shrinkage caused at this time will be regained quickly and the lambs will grow and thrive much more rapidly after being freed of the irritation caused by the ticks. If the work is done properly and the sheep handled carefully, pregnant ewes may be dipped with safety at any time up to within one month of lambing.

DIPPING PLANTS.

EQUIPMENT FOR SMALL FLOCKS.

The farmer who has but a small flock to dip can use a portable galvanized-iron vat as shown in figure 12, turning a part of his barnyard or sheds into catch pens for temporary use. The portable galvanized-iron dipping vats, called "hog vats," can be purchased ready-made and will answer the purpose very well for dipping small lots of farm sheep. They are sometimes set on the surface of the ground and the sheep lifted into them, but this method is not very satisfactory. An excavation should be made, the dimensions of which exceed slightly the outside dimensions of the vat, except the depth, which should be less, so that when the vat is set in the trench the top may extend about 6 inches above the surface of the ground. Approaches and draining and holding pens may be provided as desired.

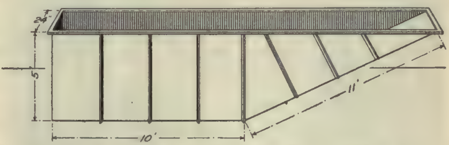

FIG. 12.—Portable galvanized-iron sheep dipping vat.

A canvas dipping bag (fig. 13) is used sometimes when only a few sheep are to be dipped at different points in a given section, as it has the advantage of being easily transported. It is made of heavy canvas, known in the trade as No. 40, and is constructed as follows: Two strips of canvas 8 feet long and 26 inches wide are sewed together to form a bag 48 inches deep and 94 inches in circumference. Seams are triple sewed and top and corners reinforced with leather strips riveted on. Iron rings held by leather ears are riveted to the upper part of the bag as shown in the illustration. The bag is filled with dip, diluted as for use in a dipping vat, the sheep's feet are tied, and the animal is set down in the bag and held the required length of time.

Heating tanks or boilers are necessary, the size varying with the number of sheep to be dipped. An ordinary iron caldron or kettle will answer the purpose for a small number of sheep. A rectangular galvanized-iron tank with large heating surface is preferable. Such a tank is set on two parallel walls, the walls forming the sides and the bottom of the tank forming the top of the fire box. An opening large enough for the escape of the smoke should be provided at the end opposite that at which the fire is fed.

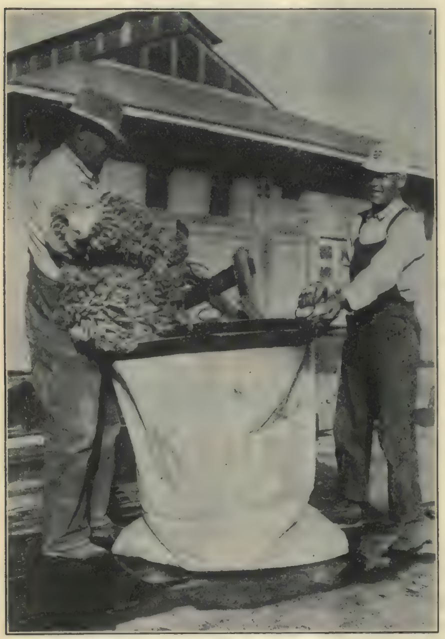

FIG. 13.—The canvas dipping bag in use.

A PERMANENT DIPPING PLANT.

When large flocks are to be dipped or when a farmer is in the sheep business permanently, it is necessary to provide proper facilities for the work and a permanent dipping plant is the only practical solution. It should be constructed and equipped so that it will be suitable for use in dipping sheep for scab as well as for ticks and other parasites.

SELECTING A LOCATION.

In selecting a location for a dipping plant the fact that sheep work better upgrade should be considered and, if possible, the ground used for the receiving corrals and chute should slope up to the end of the vat. The vat itself should be on level ground and preferably extend north and south, with the entrance at the south and the exit at the north, as it has been observed that sheep work better also when not facing the sun. If the ground selected has good natural drainage, it is a point in favor of the location.

CORRALS AND CHUTES.

In constructing a dipping plant the arrangement of the corrals is important. The receiving corrals, into which the sheep are driven preparatory to dipping, as well as the holding corrals, into which they go from the draining pens, each should be large enough to hold a full band of sheep, or about 3,000 head. The receiving corral should be constructed so that there may be the least practicable number of corners or places in which the sheep may become jammed or "piled up."

In an effort to get out a sheep will try to go back to the place where it entered the corral; therefore, if the entrance gate is near the vat the herd will tend to crowd toward the vat and thus save considerable work in getting them into the chute or catch pen. The corrals and chutes may be so arranged that a combination legging pen and running chute is provided. Sheep usually work well in a chute the first time they are dipped at a vat, but in the case of old ewes that have been dipped several times at the same vat it is often necessary to put them into the vat by hand. The location and arrangement of the chutes are sometimes changed from year to year so the sheep may not recognize them so readily. The running chute should be curved to obstruct the view, and the side on which the men work should be tight-boarded. The usual height for the sides of the chute is 40 inches, and the width of the chute 18 to 22 inches, depending on the size of the sheep. Sheep work well uphill but not down an incline; the chutes and alleys, therefore, should be upgrade to the vat. If necessary, elevate the running chute so that it slants upward to the slide board. A small pen should be provided near the entrance to the vat and so arranged that the sheep may see it. This pen, known as a "decoy pen," is filled with sheep to induce the other members of the flock to work toward the vat more readily in their efforts to join those in the pen. The size and arrangement of the corrals will vary necessarily with the topography of the location and the individual ideas or tastes of the owner.

DRAINING PENS.

When a sheep emerges from the vat it carries out a large quantity of dip in the fleece. Most of this dip drains out of the fleece very rapidly, and it is desirable that it be saved and returned to the vat. Draining pens with water-tight floors sloping toward the vat, therefore, should be provided. The size will depend upon the size of the plant and the number of sheep to be dipped. The relative size shown in the plans illustrated in figures 14 and 15 may be followed, increasing or decreasing the size of the pens to correspond to the length of the vat. There should be two draining pens, each having an opening into the holding corral. They may be made of lumber or cement and should have catch basins or screening and settling wells into which the dip drains so as to prevent manure and foreign matter from being carried into the vat. Drawings of screenings and settling wells will be found in the plan of the cement dipping plant (fig. 15). In constructing draining pens of cement it is advisable to build the outer walls in the same manner as the foundation for a house, except that they are to be 6 inches thick. The space inside these walls is then filled with gravel to the required height and the floor laid on it. Cement floors should have rough surfaces to prevent slipping. A coat of "pebble dash" over the cement floors will afford a suitable surface for the sheep to stand on, or the cement surface, while soft, may be roughened by means of a stiff broom. The floors of draining pens should slope so that the dip will drain away rapidly and not collect in pools from which the animals may drink.

VATS.

The dipping vat may be constructed of either lumber or cement, the cement vat being preferable. The length of the vat may vary from 30 to 100 feet, depending on the number of sheep to be dipped. Public dipping vats, where from 50,000 to 100,000 sheep are dipped each season, should be 100 feet long. The depth should be 5 feet, width at bottom 8 inches and at top 2 feet. Sheep vats usually are constructed so that the top is flush with the top of the ground, and there should be no crosspieces to interfere with the free action of the sheep or of the men working along the vat. As a matter of individual taste, however, the top of the vat may extend from 9 to 18 inches above the ground. Those of the latter kind afford a better opportunity to handle the sheep and can be operated with less effort than those whose top is flush with the ground. If it is desired that the top of the vat should be flush with the ground, it should first be built at least 4 inches above the natural surface of the ground and then dirt or gravel may be filled in, thus securing proper drainage along the sides.

Whenever it is possible to do so the gravity method of draining the old dip out of the vat should be adopted, as otherwise it is necessary to pump or dip it out each time the vat is cleaned. The end of the vat having the drain should be slightly lower than the other end so that all the liquid will drain off.

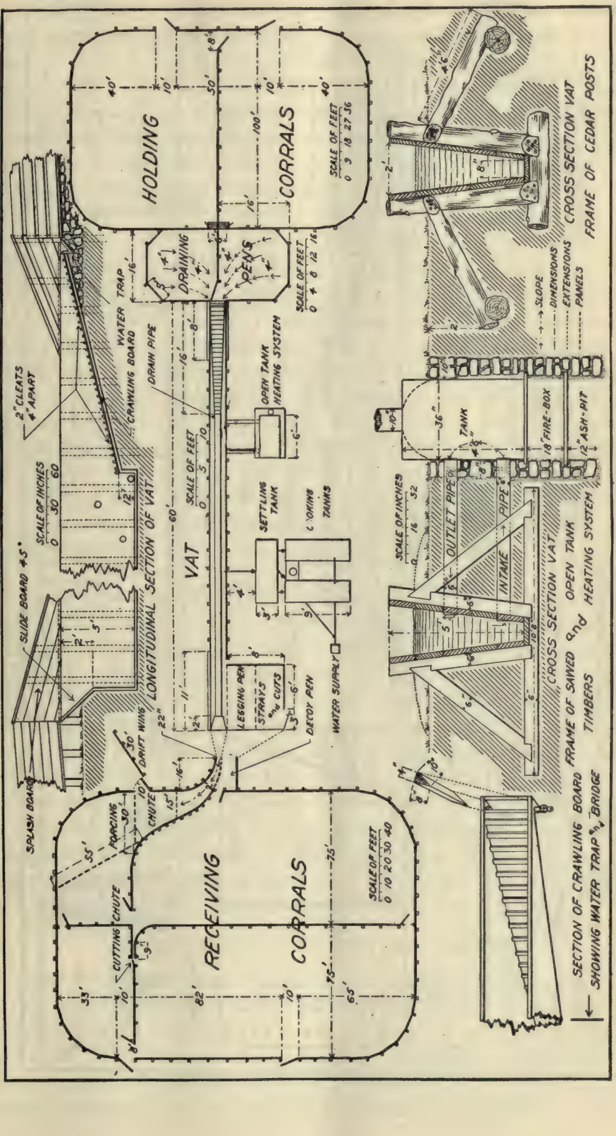

FIG. 14.—Plan of sheep-dipping plant; wooden vat.

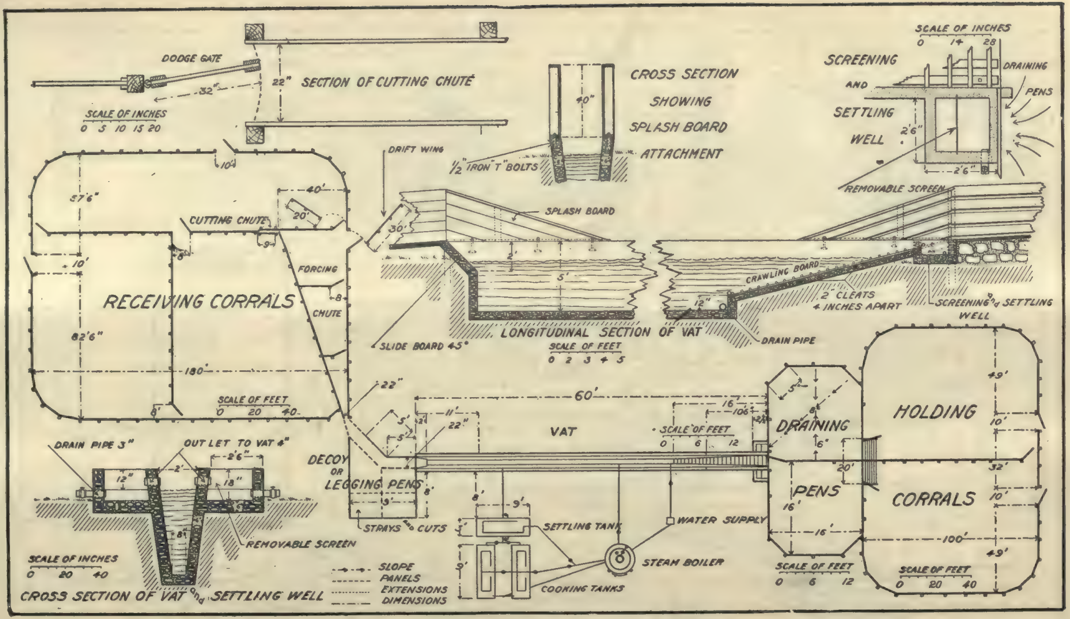

Fig. 15.—Plan of sheep-dipping plant; cement vat.

The slide board into the vat should be set at an angle of 45 degrees and extend from the floor of the chute to at least 4 inches below the dip line; it should be made of or covered with a smooth-surfaced material, such as planed lumber or sheet metal. The end extending into the dip should be flush with the vertical end of the vat. A space between the slide board and the end of the vat, if large enough for a lamb to lodge in, is a dangerous arrangement. The runway leading out of the vat should not be too steep. The length varies from 8 to 16 feet, the latter being preferable in large vats.

HEATING FACILITIES.

When lime-sulphur dip is used it is necessary to provide cooking tanks. The cooking may be done by steam or in open boilers having a fire box under each. All large plants should have steam boilers of not less than 25 horsepower. The live steam can be piped into the dipping vat and used for maintaining the temperature of the dip and also into the cooking and heating tanks for boiling the dip or heating water. The steam pipes should extend along the floor of the vat at least two-thirds of the length and be provided with openings for the escape of the steam into the dip. The supply pipe from the settling tank should enter the vat above the dip line in order that any leak may be detected easily. The open-tank heating system, if preferred, may be installed instead of the steam boiler.

CARE OF PLANT WHEN NOT IN USE.

A dipping plant that does not receive proper care when not in use deteriorates very rapidly. The pressure of the ground against the sides of the vat tends to cause them to bulge inward; this tendency may be counteracted to some extent by keeping the vat full of liquid. Wooden vats which are allowed to stand empty will dry out, and the lumber will shrink so that the vat will leak when refilled. At the close of dipping operations the vat should be left full of liquid and water added from time to time to restore that lost by evaporation.

A week or 10 days prior to beginning dipping operations the entire plant should be overhauled and put in good condition. Before charging a new vat or one which has stood empty for some time, it should be filled with water to ascertain whether it leaks.

CONSTRUCTION OF DIPPING PLANTS.

Plans for construction of wooden and cement sheep-dipping plants are shown in figures 14 and 15. They are not drawn to a uniform scale, consequently in studying the drawing the scale of each part should be noted. The plants as shown have no superfluous equipment, and the arrangements are as simple as is consistent with efficiency. The size of the plant can be increased or decreased as desired. A different corral, chute, and legging pen arrangement is shown with each vat. All these parts are suitable for use with either vat. Cross fences as desired can be added to the corrals. Cutting chutes are shown in both plans, as every large dipping plant should have such a chute equipped with a dodge gate so the lambs may be cut out and dipped separately.

If permanent pipes are used for conducting water and dip to the vat they should be laid so as not to act as an obstacle to the men working along the vat. There should be no obstructions to the path along both sides of the vat. The pipes can be placed under the ground, or a portable V-shaped trough can be used for conducting liquids into the vat and laid aside when not in use.

THE WOODEN VAT.

As shown in the plans for the wooden vat, one side of the running chute is made of portable panels so they may be shifted and the space converted into a legging pen. Two styles of framing are shown. In the cedar-growing sections the cedar-post frames are preferable because they do not decay rapidly, while the sawed white-pine timbers do. Where hardwood is used instead of white pine the frame timbers need not be so heavy; 4 by 4 inches is heavy enough for framing in hardwood. The frames are set from 2½ to 4 feet apart, depending on the character of the soil and the material used; 2½ feet apart is a safe rule, as the closer the frames are to each other the less tendency there is for the sides of the vat to bulge in between the frames. Two-inch tongue-and-grooved planks should be used in making the vat, and they should be beveled so all joints and seams may be properly calked with oakum or similar material.

The open-tank heating system is shown in the drawings. When this system of heating is used it is not necessary to have settling wells, as the heating tank acts as a settling well. It has an advantage over the old-style coil-heating system in that the pipes are easily cleaned if they become clogged. A water trap is provided for in the exit end of the vat with a bridge to fit into the trap while dipping is being done. When dipping operations are finished for the day the bridge should be removed and the valves of the drainpipes opened so water from the draining pens may not run into the vat.

THE CEMENT VAT.

In the plan for the cement plant the corrals and chute are very conveniently arranged. The portable panels can be shifted to form either a running chute or a legging pen. The settling and screening wells shown also can be constructed as a part of any vat by changing the slope of the draining pens so the dip will run into the wells instead of down the runway. In making the forms for a draining well, the groove into which the removable screen is to sit should be provided for, as well as the 4-inch openings for drain and outlet pipes.

The trench for a cement vat should be excavated so that the inside dimensions correspond with the outside dimensions of the vat when completed. If the sides of the trench are smooth and reasonably firm they can be used as the outer wall of the form, but in all cases where the vat is extended above the surface of the ground it is necessary to build forms extending from the surface of the ground to the top of the vat. If the soil is sandy it will be necessary to build outer forms, in which case the trench should be wide enough to allow for these forms. The drain and other pipes shown in the drawing should be placed in the form and should all be threaded and capped so that proper connections may be made. The ½-inch iron bolts and the iron pipe shown in the drawings should be embedded in the cement of the incline for attaching the false floor or crawling board. The floor is made of 1 by 6 inch boards laid lengthwise with cross cleats as shown in drawings. The splashboards at the entrance end of the vat and the guides at the exit end are nailed to 2 by 4 inch scantling bolted to the cement wall, and the bolts should be embedded when the wall is being constructed. Two pairs of bolts should also be embedded for attaching the slide board. Steam pipes should not be molded into the concrete walls, as the vibration of the pipes will crack the cement. They should pass over the top of the vat and down the side in a groove formed in the wall, so they will not come in contact with the sheep or cause annoyance to the men working along the vat.

The walls should be made 6 inches thick, constructed of concrete mixed in the proportion of 1 part cement, 2½ parts sand, and 4 parts broken stone or gravel. This mixture is slushed into forms properly set, and when it approaches dryness the forms are removed and the inside surface of the vat coated with pure cement mixed to about the consistency of cream and applied with a brush. It is important that this coating be well brushed in so as to fill all cavities and form a smooth surface. Finishing coats of sand and cement applied with a trowel after the forms have been removed are liable to crack and scale off.

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CARBON DISULPHID AS AN INSECTICIDE

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CHEMICALLY pure carbon disulphid is a colorless watery liquid formed by the union of two elementary particles of sulphur with one of carbon. Its chemical symbol is therefore CS_2. The name is spelled in several ways: Disulphid, disulphide, bisulphid, and bisulphide. The colloquial name most frequently used appears to be "high life."

This bulletin gives the necessary facts regarding the nature of carbon disulphid and the general principles involved in the safe, economic, and effective use of this valuable insecticide. It is a revision of Farmers' Bulletin 145, which it replaces, but it includes new information based to a large extent on work conducted by the author at the Alabama Experiment Station and published here with the approval of the director of that station. The bulletin is adapted to all parts of the country.

CARBON DISULPHID AS AN INSECTICIDE.

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INSECT PESTS WHICH MAY BE KILLED BY CARBON DISULPHID.

Carbon disulphid is a liquid which evaporates quickly when exposed to the air, forming a heavy inflammable vapor having great penetrative power so that it is very useful in destroying insect pests. This substance is used most extensively to kill weevils and other pests that injure stored grains, beans, cowpeas, and peas, but it may be employed with advantage to kill many other kinds of insects. These may be arranged in three groups. In one group are species that live underground on the roots of plants or that nest in the ground, as do some aphids, the white grubs, mole crickets, ants, and others; in the second group are species that attack various stored products, such as grain insects, pea weevils, bean weevils, pantry pests of various kinds, and mill insects; and in the third group are species that can not be controlled by the methods commonly employed for their near relatives. In this last group belong certain other insects that can not be combated satisfactorily by spraying and various wood borers that can not be reached with poisons but can be reached easily with vapors.[1]

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[1] It should be noted that the degree of infestation does not affect the dosage required.

FORM IN WHICH CARBON DISULPHID IS SOLD AND WHAT IT COSTS.

In small quantities carbon disulphid is put up in tight tin cans; in large quantities (50 to 1,000 pounds), in steel drums. It may be purchased in small quantities from most druggists at from 25 to 35 cents per pound, but if any considerable quantity is to be used it is better to buy from some wholesale druggist, or, better still, directly from the manufacturers. Manufacturers can supply impure grades, which are commonly used for insecticidal work, at a cost of from 10 to 15 cents per pound. The charge for steel drums is paid by the purchaser, but the drums are returnable at purchase price. Addresses of manufacturers may be obtained from any entomologist or from the director of any experiment station.

PROPERTIES OF CARBON DISULPHID.

LIQUID PROPERTIES.

Liquid carbon disulphid is about one-fourth heavier than water. It evaporates very rapidly upon exposure to the air, the rate of evaporation depending largely upon the area of the exposed surface, the temperature of the air and of the liquid, and the height of the wall of the container above the surface of the liquid. Evaporation may be retarded by mixing the liquid with various substances and is almost wholly prevented by covering the surface with water, which, being lighter, floats easily on top just as kerosene floats upon water. The evaporation takes up heat in proportion to its rapidity so that it may produce frost upon a hot day near the evaporation surface. If the liquid is poured upon the hand or anywhere upon the skin a burning sensation will be felt. This is due not to a burning but to a cooling process, as may be perceived readily by touching the spot with the other hand. No injurious effects result from getting it upon the skin, although it takes out the moisture and oil, leaving the skin dry and whitish. If confined on the skin, as under a ring, it causes sharp, burning pain, and this doubtless is similar to the sensation felt by animals when the liquid is poured into the hair, which serves to retard evaporation.

The chemically pure liquid has a sharp taste and a rather sweetish, not unpleasant, odor which is very similar to that of ether or chloroform. The *pure* chemical is completely volatile and will not injure or stain the finest fabrics. It does not affect the edibility of foodstuffs upon which it may be poured, and all trace of the odor disappears quickly upon full and free exposure to the air. The ordinary commercial article, however, has a decidedly yellowish color, due to the excess of sulphur, and a decidedly unpleasant odor, due to the hydrogen sulphid contained in it. *The commercial article, there-*

fore, should not be poured directly upon goods that would show stains or upon food materials, although the vapor from it will not do them harm.

Liquid carbon disulphid is not at all explosive, and there need be no fear in handling it if the cans are perfectly tight. It boils at 115° F., which is about the highest temperature of water in which the hand can be held. One volume of the liquid is said to produce about 375 volumes of the vapor. The liquid weighs a little over 10½ pounds per gallon at ordinary temperatures.

VAPOR PROPERTIES.

The vapor of carbon disulphid is two and sixty-three one-hundredths times as heavy as air, and therefore can be poured from one glass to another, almost like water. The vapor easily can be seen flowing down over the edge of an open vessel containing the liquid. It diffuses rapidly through the air, as can be perceived from the spread of the odor, but as it tends always to work downward rather than upward, the vapor is more dense and has greater killing power at the lower levels. This point has an important bearing upon the application of the material. The vapor appears to have greater penetrative power than does that of any other volatile liquid that has been tested in insecticidal work. This power is far greater than that of hydrocyanic-acid gas, which is another fumigant frequently used. It is possible, therefore, to use carbon disulphid with good results for the treatment of materials which would not be penetrated by other fumigants under natural atmospheric conditions. The expansive tendency is so great that the vapor may exert a pressure of several pounds to the square inch in the container if the temperature of the liquid is increased. The vapor is highly inflammable and explosive when mixed with air in certain proportions.

EFFECTS UPON HUMAN BEINGS OF INHALATION OF VAPOR.

The gas is rated as highly poisonous, producing giddiness, vomiting, congestion, coma, and finally death. These are, of course, its extreme effects. In its ordinary use on a large scale in the fumigation of mills, warehouses, etc., where the worker may be exposed to inhalation of the fumes for some time, only those effects which precede giddiness are likely to be felt. The first appreciable effect is the perception of a very disagreeable odor, but this odor gradually ceases to be noticed, showing that the sense of smell has been deadened. Workmen may even question the fact that they are handling the same material as at the start. The other senses seem to become benumbed simultaneously, so that the operator does not realize that anything is the matter with him. The heart beat becomes more rapid as the oxygen in the lungs diminishes. The power of thought is very much weakened, and the work is continued in a mechanical way. Hearing and sight are both weakened. But before this weakening process has gone far enough to be really dangerous or injurious the operator probably will feel more or less dizziness. There is no pain or disagreeable sensation, no desire to get away from the vapor, and no sense of suffocation. But when a person has reached this condition it is high time to get into the fresh air.

Owing to the effect of the vapor upon heart action, persons having any trouble or weakness about the heart are cautioned against taking any extended part in the application of disulphid.

It should be understood clearly by those who use it that the action of the vapor is somewhat poisoning as well as suffocating. Should the operator persist in remaining in the room after the dizziness comes on he would be in danger of falling, and, if not discovered, he would soon suffocate. Even if he should get out safely the ill effects would be more marked, and a severe headache, at least, might ensue. If upon the approach of dizziness the operator goes at once to a window, or, better still, out of doors, an abundance of fresh air will remove the ill effects in a few minutes.

The inhalation of the fumes can be retarded somewhat by tying a wet handkerchief tightly over the face. This, however, merely diminishes the amount of air taken into the lungs without affecting the proportion of vapor contained therein. When obliged to enter a room in which there is any considerable amount of the vapor the writer makes use of the following device, which is perfectly effective for a short period. A large paper bag (20 quarts or more) is tied tightly around a short piece of tubing of glass, rubber, or metal inserted into its mouth. When inflated the bag contains sufficient air to enable one to respire into it for several minutes without any discomfort. Being light, it is carried easily by the tube in the mouth so that the hands are left free for any work desired.

PRECAUTIONS TO BE OBSERVED IN HANDLING AND STORING.

The dangers involved in fumigating rooms with carbon disulphid have been discussed rather fully, not because they are very great but in order to lessen the fear that is likely to be great with a material known to involve dangers not fully understood. Danger may be avoided by an intelligent understanding of the precise nature and effects of the chemical. The danger with carbon disulphid is practically of the same nature as that with gasoline, which has come into common use in recent years in many thousands of homes and with hundreds of thousands of automobiles. In reality the danger is less, since every effort is made to keep carbon disulphid from the presence of fire, while gasoline is used principally in connection with fire. The only peculiar thing about carbon disulphid is that the vapor ignites at a lower temperature than does that of gasoline. It may ignite from any form of fire, or even without the presence of flame but with a temperature of above 297° F. *There must therefore be no smoking or carrying around of lights where carbon disulphid vapor is strong, and it is hardly safe to have steam pipes very hot, or to turn on or off an electric light or fan. Even the heavy striking of a nail with a hammer might cause an explosion if the necessary density of vapor were present.* Carbon disulphid should not be applied to corn in the bin or to other grain when the mass is known to be in process of heating spontaneously. The disulphid should be stored in a cool, dry outhouse away from fire and where the containers will not rust out and allow the liquid to escape or evaporate. As a further precaution, all containers should be labeled in red, "DANGER—FIRE."

CONFINEMENT OF THE GAS IN FUMIGATION.

Carbon disulphid is applicable only where the vapor can be confined quite closely. The period during which it is necessary to keep the vapor confined varies with the resistant power of the insect species, but in nearly all cases must be for more than 30 minutes, even when a heavy dosage is being used. It is possible for the gas to be confined sufficiently by the soil, the burrow, a tight room or bin, etc., or even by the large volume of a material through which it can only diffuse slowly.

GAS-TIGHT MATERIALS.

Many writers have referred to tightly closed rooms which are plastered or carefully ceiled as being "gas-tight." As a matter of fact, no such room can be made anywhere near gas-tight. Ordinary living rooms, even in well-built houses, are so very far from gas-tight that a large excess of the fumigant is necessary to get anything like satisfactory results in them. It is not strange, therefore, that a wide divergence appears between the results of experiments made by a scientist in some laboratory in glass receptacles which are truly gas-tight and the results of fumigation work under ordinary building conditions, both in the strength of gas required to kill all insects and in the time in which this can be accomplished.

A somewhat extensive testing of materials has shown that ordinary 10-ounce duck, untreated, will transmit practically 85 per cent as much air under a slight pressure as though there were no such obstacle in the way. All felt materials are extremely porous and are unsatisfactory for use in packing around doors, etc., as they are often used. Heavy, hard-rolled wrapping paper, or 2-ply roofing paper of certain brands, is actually gas-tight and may be used as a lining material between layers of boarding in the construction of fumigation rooms and for pasting over cracks where necessary to tighten a room. Ordinary matched flooring or ceiling alone is very far from being tight.

MAKING A FUMIGATION ROOM OR BIN.

One of the simplest satisfactory containers for fumigation on a small scale is a water-tight barrel. This may be used for the treatment of peas, beans, etc., or for other materials that may be contained therein. The top of the barrel is best closed by spreading heavy wrapping paper, double thickness, over and around the top and tying it tightly.

In making a special room or bin for fumigation work it is best to put on one layer of boards of uniform thickness, flooring or ceiling, and then to cover this with a layer of heavy building paper, tarred paper, or similar material, which is folded or bent to fit into the corners and then is laid so as to overlap 3 or 4 inches and the edges securely pasted or cemented together so as to make it practically one solid piece of gas-tight covering. A final layer of boarding running in an opposite direction to the first is applied to protect the paper from being broken as it is used. Windows should be small and arranged for convenient opening from the outside for ventilation, and door bearings should be against paper surfaces instead of cloth or felt. In such a room or bin fumigation may be practiced with the maximum of efficiency and economy. The application of an ineffective amount of the fumigant is practically a waste of all the material used and often also a waste of the products ineffectively treated.

DIFFUSION OF THE VAPOR.

The vapor diffuses rapidly in the open air, as is evident from the spread of the odor. As has been stated, it must be confined closely in order that a sufficient proportion of it may be maintained in the atmosphere to kill insects, which require far less air, even in proportion to their size, than do higher forms of animals. The vapor naturally tends to spread outward and downward, since it is heavier than air. Consequently when carbon disulphid is applied to a bin of grain or similar material it has been found that the killing proceeds outward and downward from the point of application of the liquid and forms what may be called a "cone of killing." The apex of the cone is close to the point of application, and the base is against the floor or ground below.

EFFECT OF TEMPERATURE IN FUMIGATION.

An extremely important factor that has been ignored until recently in fumigation work is temperature. The effect of temperature may be judged from the fact that a warm atmosphere will require far more of the carbon disulphid vapor to saturate it than will a cool atmosphere. To saturate 1,000 cubic feet of air at 50° F. requires 53.5 pounds of liquid carbon disulphid; at 59°, 64.6 pounds; at 68°, 77.6 pounds; at 77°, 92.4 pounds; and at 86°, 109.3 pounds. Thus at 86° F., which is a temperature not uncommon, the air will hold more than twice as much disulphid vapor as it will at 50°. Not only is this true, but insects show great differences in vital activities at these varying temperatures. The higher the temperatures, up to a certain point, the greater their activity; and the more active the insects are, the more susceptible to the effects of the gas. In practical work it has been found that it is not advisable to try fumigation with carbon disulphid when the temperature is below 60° F., while the most effective and economical work can be done at the higher air temperatures.

AIDING RAPID VAPORIZATION.

In several ways vaporization may be hastened beyond the rate at which it will occur naturally from the surface of the liquid as it is freely exposed to the air. One common method for use in the treatment of rooms and bins on a small scale is to saturate some absorbent material with the desired amount of liquid and hang it near the top of the room or bin so that the vapor may flow away freely downward and produce quickly the maximum density of vapor. Another method sometimes used in large warehouses is to apply the liquid through a spray pump. The operator using this method must be careful not to stay too long in the gas thus rapidly increasing in density. Where the liquid falls upon wood it is taken up quickly by the wood and is then given off again, but slowly. Spray applications sometimes can be made through holes bored in the ceilings or through the floor of the room above that to be treated, and the spray thus distributed at various points in the room below with no inconvenience to the operator. The holes can be stopped securely except when in use. Still another method, which is a modification of the spray method, is to force the liquid under pressure, mixed with a large amount of air, into the material to be treated so that the gas will have to diffuse throughout the material before it can escape and lose its killing power. The more quickly the full killing strength of gas can be attained, the more economical and effective the treatment is likely to be. This method is used especially with cotton seed for boll-weevil destruction.

HOW CARBON DISULPHID KILLS.

The way in which carbon disulphid kills has been studied at the Michigan experiment station,[1] where the conclusions have been reached that carbon-disulphid vapor very probably acts upon the fatty tissues in the insect body, dissolving them to some extent; that it tends to coagulate the proteins; and that it prevents the assimilation of oxygen and the carrying on of other processes which are of vital importance to insect life. A certain amount of respiration goes on at all times so long as an insect is alive, but it is evident that respiration will be far less in the egg stage or during the dormant periods in an insect's life than it is in the adult stage and during the periods of its greatest activity. The strength of vapor and the time required to kill, therefore, will vary greatly and accordingly. Similarly, slow-moving insects usually are harder to kill than the quick-moving forms.

TREATMENT FOR INSECTS INFESTING STORED GRAINS, PEAS, ETC.

The most important use for carbon disulphid as an insecticide in the United States is in the fumigation of stored grains, cowpeas, beans, and peas to kill the insects infesting them. Many species of insects are concerned in this inquiry, but all are susceptible to the same treatment. The most important species attacking corn is the so-called black weevil, or rice weevil,[2] which causes a loss amounting to several million dollars annually in each of the South Atlantic and Gulf States. Probably half of this loss could be prevented by certain inexpensive changes in the methods followed in the planting and handling of the corn crop, but for the other half no method of prevention yet tested can equal fumigation with carbon disulphid.

Investigation by the Alabama Experiment Station has shown that the amount of liquid disulphid required for killing grain insects under ordinary conditions of storage is much greater than has been recommended usually, and ranges up to about 20 pounds per 1,000 cubic feet in ordinary rooms where the walls and floor have not been made especially tight, as recommended on pages 12–13.

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[1] Shafer, George D. How contact insecticides kill. *In* Mich. Agr. Col. Exp. Sta. Tech. Bul. 21, p. 18, 1915.

[2] *Calandra oryza* L.

In large masses of corn containing more than 1,000 bushels, where the corn still has the husk on,[1] it is possible to kill enough insects in the interior of the mass to pay for the fumigation, even if the mass is entirely open to the air above and around it. The husks in so large a mass serve to retain the gas long enough to kill weevils, etc., but it would be better in this case to increase the amount of disulphid to 25 or 30 pounds, dividing it into two equal lots and applying one lot at first and then the other after an interval of an hour. The liquid may be poured directly on the grain, as it will not injure it for feeding purposes or in germination. It is hardly possible thus to treat husked, or even shelled, corn without having a tight room or bin in which to do the work.

In fumigating corn in the crib or storage room it is best to level off the corn and then, if the husk is on, to throw out enough ears to leave five shallow holes in quincunx arrangement (i. e., one at each corner of a square and one in the center, thus: ⁙). If the surface area of the stored corn is oblong it may be divided approximately into squares and five holes, arranged as indicated, made in each square. A proportional part of the entire dosage is then poured into each hole and the ears quickly replaced. The room should be closed as tightly as possible, and it may be left closed indefinitely. The best results are obtained by doing this work when the temperature is above 75° F. Fumigation should begin at about 10 or 11 o'clock in the morning, so that the warmer temperature of midday may increase the effectiveness of the gas.

Cowpeas and other leguminous seeds can be stored and fumigated conveniently in water-tight barrels, which are filled with the seed to within a few inches of the top. The dosage needed, about $\frac{1}{2}$ cupful per barrel, may be poured directly upon the peas or into absorbent material packed on top of them. The barrel then should be covered with a double thickness of heavy wrapping paper tied closely and tightly around the top. After a few days the peas should be examined, and if insects are still active they should be treated again, a stronger dosage being given or the work done on a warmer day. The barrels may be kept covered with the paper to prevent reinfestation. The sooner peas are thrashed out and thus treated the better. Treatment should kill immature weevils as well as adults. Other seeds intended for planting can be treated and protected in a similar manner.

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[1] HUSK CORN IN THE FIELD.—In the Southern States it has been long the prevailing custom to gather the corn by breaking the ear from the stalk and to store it with the husk on. For several reasons insect injury during storage is generally far greater in the South than it is in the North. Storing corn with the husk on has been supposed to protect it against insect attack in some measure. Recent investigations have shown that this is a mistake in practice. The insect attack begins in the field as soon as the kernels begin to harden and the husk to shrink away from the ear. *Storing with the husk on insures carrying practically every insect from the field to the crib. It practically doubles the volume of storage room required per bushel of corn and also increases greatly the amount of carbon disulphid needed to treat the corn in the crib. Husking the corn in the field, on the other hand, will leave at least three-fourths of the adult insects in the field and thus help greatly in reducing subsequent injury during storage, besides making crib treatment more effective and economical.*

There is no need for an open crib in which to store the thoroughly well-matured corn of the South. Storage rooms may be made tight enough for fumigation and the dosage required for bare ears will be only about 10 pounds per 1,000 cubic feet, or one-half the amount needed with the husk on. Store as soon as the corn is thoroughly matured and fumigate promptly for best results. If insect attack develops in the crib, treat again, using a heavier dosage, or doing the work during warmer weather.

TREATMENT OF BUILDINGS.

Agricultural products frequently are brought together in storehouses, mills, etc., in immense quantities, and when allowed to stand for months, as is frequently the case, these materials become particularly favorable places for the nourishment and multiplication of a large variety of insects which can be dealt with only by treating the entire building. It is possible that this fumigation treatment might be objected to by fire-insurance companies as a violation of the policy contract, but there is no record of fire ever having occurred from such treatment of warehouses or mill buildings.

PRELIMINARY INVESTIGATIONS.

When a fumigation of this kind is to be undertaken, a preliminary investigation should be made to determine the nature of the principal pest (or pests), its habits, manner of injury and of breeding, and as much of its life history as may be needed to determine whether one time will be more favorable than another for the treatment. The building or room should be examined thoroughly to determine how it can be made as nearly tight as possible, and its floor area and cubical contents computed. All possible objections to treatment and all dangers involved should then be considered. As a general rule, the advice of a competent entomologist may be obtained free through the State experiment station, and in many cases the entomologist can be secured to take personal charge of the preparation of the building and the application of the treatment.

PREPARATION OF THE BUILDING.

The building should be made as nearly gas tight as is possible and the places into which the insects might crawl for shelter should be eliminated so far as practicable. The pasting of heavy wrapping paper over cracks around the floor edges and around windows, doors, etc., is one of the cheapest and best ways of closing these spaces. Insects sheltered in such cracks may be killed by local treatment. The building should be swept out thoroughly, and a coat of whitewash may be needed sometimes before the treatment is applied. As much as possible of the infested materials should then be exposed to the strongest action of the vapor. With this in view, materials should be removed from shelves and spread out on the floor. If there are serious objections to allowing the liquid to touch the materials to be treated, it will be necessary to provide a large number of shallow tin pans or plates. The larger these are the better. They should be placed as high in the room as can be done without delaying the application unduly, and care should be taken to see that they are level, although ordinarily no harm will be done if some of the liquid is spilled. No time can be lost in making such adjustments after the application is begun. To reach places which are not accessible by the pan method, it may be possible to use cotton waste or other absorbent material, saturating it with the disulphid and throwing it or hanging it where needed. If the liquid has been purchased in bulk it may be necessary to have several convenient smaller receptacles into which it may be poured so that it can be handled conveniently and rapidly.

MAKING THE EXPOSURE.

As many men should assist in making the exposure as can work to advantage, for the work must be done rapidly. Before the cans or drums are opened every man should receive full instructions as to his division of the work, and cautioned as to the dangers from fire, dizziness, etc. If more than one floor is to be treated, the men should begin at the bottom and work upward on account of the rapid settling of the gas. Every door and window should be closed tightly except that left for escape of the workers. All should begin at the same time, pouring the predetermined amount into each receptacle, and then get out into the open air as quickly as possible. The exit door should then be closed, with paper pasted around it to make it tight, and it should be left closed for 12 hours or longer. The best plan usually is to make the treatment on Saturday afternoon before dark, or on Sunday forenoon, and allow the building to remain locked until early Monday morning. Owners of adjoining premises should be advised regarding the nature of the work. and a watchman may be needed in some cases during the period of treatment.

VENTILATION.

As a matter of fact, most, if not all, of the killing will have occurred during the first 6 hours of the exposure and the building may be ventilated after that time, as a minimum, has elapsed, although it is better to wait 12 hours or longer. In cases of long exposures the vapors will have diffused so fully by the end of 24 hours that there will be no danger to anyone entering the building to open it for ventilation. If, however, it is found that the gas is still very strong, the respiration bag, as described on page 6, should be used. The odor disappears rapidly where the air is moving at all. Traces of it may linger in close or damp corners for some time, but there is no danger from fire or to health from slight amounts of vapor.

FUMIGATION OF SACKED COTTON SEED.

On account of its fuzzy nature and the immense number of small air spaces formed in tightly packed masses of cotton seed, this material has proved to be a difficult subject for fumigation. Hydrocyanic-acid gas does not penetrate more than a few inches into cotton seed, which carbon-disulphid vapor can penetrate for several feet downward from the point of application of the liquid, but the penetration by its own force is slow and the loss of time is unnecessary. A method of forcing specified quantities of the liquid and its vapor into the interior of the mass of cotton seed, or into sacks of seed, has been devised and described.[1] By this method a squad of four men can treat 600 or more sacks of seed a day. A charge of 1 ounce of disulphid is used for each sack of seed containing about 3 bushels, and the liquid and its vapor are driven into and diffused through the seed by pressure of air obtained from a small air pump. The cost for liquid used amounts to less than one-third of a cent per bushel, and the expense for the treatment, including labor, will be about one-half cent per bushel. This method of application can be used with many other subjects to good advantage. The liquid and vapor are released in the interior of the mass to be treated, thus confining all the vapor and forcing it to diffuse throughout the material before it can escape and lose its killing power.

DESTRUCTION OF ANTS.

Carbon disulphid is the best remedy known for the destruction of colonies of ants, which frequently become great nuisances to householders, farmers, and gardeners. With a little careful observation most of these ants, except possibly the little red house ant, can be traced to their outdoor homes. It helps little to destroy even a large number of the workers, as the supply will be renewed quickly through the rapid breeding of the colony. The only really effective way of stopping the annoyance or injury is to destroy the queens which lay the eggs and rarely leave the nests.

In work with the Argentine ant in Louisiana[2] it was found that the colonies could be localized during the winter season or in very wet situations by furnishing warm places for the nesting of the ants. For the winter, trap boxes 2 by 2 by 3 feet in size were filled with leaves, cotton seed and straw or other porous material. These were placed in the open about the 1st of October, so that the contents might be wet by the rains and then become warm through the process of decay. This material proved so attractive to the ants that practically all colonies within a radius of 30 or 40 yards would take up their abode in it as cool weather came on. In a single trap of this kind it was estimated that more than 1,000 fertile queens were present. In midwinter the cracks in the box were closed tightly, the top covered with a waterproof canvas, and carbon disulphid applied, so that all ants were destroyed at once. This appears to be one of the most economical and effective methods for controlling the Argentine ant.

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[1] Hinds, W. E. Fumigation method for sacked cotton seed. *In* Jour. Econ. Ent., v. 8, no. 4, p. 400–402, pl. 21. 1915.

Hunter, W. D. The boll-weevil problem, with special reference to means of reducing damage. U. S. Dept. Agr. Farmers' Bul. 512, p. 37–39, fig. 9. 1912.

[2] Newell, Wilmon. Measures suggested against the Argentine ant as a household pest. *In* Jour. Econ. Ent., v. 2, no. 5, p. 324–332. 1909.

In the destruction of colonies of the agricultural ants which are very common in the southwestern States carbon disulphid treatment has given most satisfactory results.[1] The liquid is evaporated under an airtight, galvanized-iron tub, which is inverted over the entrances to the colony. The fumigation is begun when the gateways to the nest are open, thus permitting the vapor to flow into the tunnels and penetrate to the lowest chambers in the nest. If other openings occur that can not be covered with the tub at one time, they should all be closed by piling dirt around the tub. One to three ounces of liquid should be used, depending upon the apparent size of the nest, and the tub allowed to stand for five or six hours. By this time all ants will have been killed, and the tubs may be moved to other colonies.

Where ants infest the surface soil generally throughout a considerable area, holes not more than 18 inches apart and several inches deep may be made with a stick or iron bar, an ounce of disulphid poured into each, and the holes closed immediately. After the whole area has been treated the ground should be wet thoroughly or covered with waterproofed canvas, or paper, or wet blankets, to aid in confining the gas.

USE OF CARBON DISULPHID AGAINST WHITE GRUBS AND MOLE CRICKETS.

White grubs, which are the young of the so-called May beetles or June beetles, occur throughout the United States and frequently are so abundant as to demand treatment. Their period of development is long, extending over two or three years, and during this period they are feeding upon the roots of plants. Mole crickets are most abundant in the Southern States and in the islands in the Gulf of Mexico, and they produce a full generation each year. Both of these common pests in gardens and lawns may be destroyed by the method recommended for use against ants infesting the soil. For best results the soil should be fairly permeable and at least 8 inches in depth.

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[1] Headlee, T. J., and Dean, Geo. A. The mound-building prairie ant. Kans. Agr. Col. Exp. Sta. Bul. 154, p. 178–180. 1908.

TREATMENT FOR APHIDS LIVING UNDERGROUND.

The first extensive use of carbon disulphid as an insecticide was against the grape Phylloxera in France. The Phylloxera is a species of aphis which lives upon the roots of the vine. It is native to America but was introduced by accident into France about 1859, where for a time it threatened to destroy the grape-growing industry. By 1863 more than 200,000 acres of vines were being treated annually with carbon disulphid for this pest. The following paragraphs give a brief summary of the principal conclusions reached by French workers in their fight against the Phylloxera. They are included here because they have a general application to all fumigation for underground insects.

DIFFUSION OF THE VAPOR IN THE SOIL.

The liquid evaporates in the soil as it does in the air, only much more slowly. The vapor diffuses through the air spaces of the soil, producing an atmosphere that may be fatal to all insects reached by it. The rate of evaporation, extent of diffusion, and persistence of the vapor in the soil vary widely in soils of varying character and condition. It becomes necessary, therefore, to vary the rules for application according to the influence of these factors to secure the destruction of all insects without injury to the plants.

EFFECT OF SOIL MOISTURE.

Carbon disulphid evaporates most rapidly in a warm, dry, sandy soil, and the persistence of the vapor is shortest in such soil. In fact, in such soil the diffusion is so rapid that most insects will survive an ordinary treatment, and if the dose is increased greatly to kill the insects there is grave danger of killing the plants also. Treatment can not be applied successfully in such soil unless the surface soil can be wet or covered after the treatment. On the other hand, diffusion is slowest in very heavy, wet, clay soils, and when the soil is saturated with water the evaporation is almost entirely prevented. Moisture lowers the temperature and decreases the permeability of the soil; it also prevents evaporation and retards diffusion. Between these two extremes there is a medium character and condition of the soil which is most favorable for the treatment.

EFFECT OF CHARACTER OF THE SOIL.

Sandy soils permit an even but too rapid diffusion and loss of vapor. Rocky soils are not of even texture, and naturally the vapor follows the line of least resistance. Heavy clay soils, when very dry, are usually much broken by cracks and fissures which may run from the surface to a considerable depth and permit the gas to escape without permeating the soil to any considerable extent. When such soil is moderately moistened it is even in texture and favorable to treatment.

DEPTH OF SOIL.

The depth of the soil is an important factor in determining how much disulphid should be used for a given area. If surface soil is very shallow and the subsoil very dense and impervious, it is evident that much less liquid will be required to produce a killing atmosphere than will be needed in soil of much greater depth. The amount of liquid used should be proportional to the permeable depth of the soil. In heavy, compact soils increase the number of injections and diminish the dose in each; in light, deep, permeable soils decrease the number of holes and increase the dose in each.

AMOUNTS TO USE.

Grapevines growing in medium fine, moderately moist soils were uninjured by doses of from 1 to 1½ ounces in each of three holes made at about 16 inches from the base of the vine and at a depth of about 20 inches, while 2½ ounces to a hole proved fatal to them.

REPEATED TREATMENTS.

Best results are obtained by dividing the amount of liquid to be applied and giving two applications of the half dose, separating the applications by from 6 to 10 days. The holes made for the second treatment are then placed intermediately between those used for the first. The depth of holes may range from 12 to 16 inches. Spring is the most favorable season for treatments.

TREATMENT FOR ROOT-MAGGOTS.

Carbon disulphid has been used with varying degrees of success for the cabbage root-maggot since 1880. Its efficacy varies considerably with the nature of the soil, and many of the failures reported have been due very largely to improper or too tardy application. If the liquid comes into direct contact with the roots of the young plants, it is sure to prove fatal, but a considerable proportion of the vapor will do no harm. If treatment is delayed until after the plants have wilted, it is very likely that they will not recover, even though the enemy may be killed, but the death of such plants in such cases can not be attributed fairly to the disulphid treatment. Many growers who have tested it thoroughly claim that it will work in either clay or sandy soil, and that it destroys both maggots and pupæ. In applying the disulphid for root-maggots the dose is distributed in one or two holes made not nearer than about 4 inches from the base of the plant and running down to a point a little below the roots. The holes must be closed tightly with earth and compacted by pressure with the foot. The dose varies from 1 teaspoonful for each small plant to a tablespoonful for large plants.[1] One injection should be sufficient if made in time, but if delayed too long nothing can save the plants.

TREATMENT FOR APHIDS ON LOW-GROWING PLANTS.

Aphids frequently become extremely abundant upon melon, citron, and other cucurbit vines and upon young cabbage plants, etc. Here they are very hard to control by spraying with contact insecticides because of the curling of the leaves. Carbon disulphid has been used successfully for the control of melon aphids by evaporating the liquid under a tub which covers the vines. Another form of covering used for the plants is a box made of a light frame of wood about 24 inches square by 8 inches high, covered with closely woven muslin cloth which is soaked with linseed oil and then dried to make it gas-tight. The cloth is made to project some 6 or 8 inches beyond the frame so as to form a loose flap around the outside upon which dirt can be piled to make the covering fit tightly to the ground. These boxes are light, durable, and convenient to handle.

The dose consists of 1 teaspoonful (1 dram) of liquid to a plant, or for a box containing about 1 cubic foot, and should be increased proportionately with larger boxes. If the receptacle is of irregular shape, but water-tight, the contents may be determined very accurately by filling it with water. It takes very nearly 7½ gallons (30 quarts) of water to fill 1 cubic foot of space.

The liquid may be evaporated from a shallow dish, or arrangement may be made so that the liquid can be poured through a large hole in the top of the box into some absorbent material fastened permanently beneath it, and the hole then closed tightly with a stopper. On account of the small space that is being treated, special care should be taken to measure the amount of liquid accurately. The covers should remain in place for one hour and then be moved to fresh plants. With from 50 to 100 boxes, a field may be treated with comparative rapidity, and the vapor will reach the aphids much more thoroughly than if applied in any other way. Plants will be more resistant to the vapor at night, when the breathing pores (stomata) are closed.

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[1] Four teaspoonfuls are approximately 1 tablespoonful, and 2 tablespoonfuls are approximately 1 fluid ounce.

DESTROYING WOOD-BORERS.

Much has been written concerning the use of carbon disulphid to destroy borers in wood. It is evident that only the larger borers which work in the trunks and larger branches of valuable shade and fruit trees will be good subjects for this work. Usually there are few of these large borers in a trunk, and the outlets to their burrows are marked by the "saw-dust" and castings which they throw out from them. In attempting this treatment, first close all burrows with a clay plug and after a day or two re-examine them to see what burrows are really occupied. Clean-cut, empty holes in the trunk are likely to be only the exit holes from which insects have emerged, so it would be a waste of time and materials to treat such cavities.

METHOD OF TREATMENT.

Having cleaned out the mouth of the hole as well and deeply as possible, roll a small wad of cotton on a toothpick, wet it with disulphid, push it into the cavity as far as possible, and immediately close the hole tightly with putty or, better, with grafting wax. Only a drop or two of liquid is likely to be needed and it should not be applied so as to run down into the burrow as a liquid. The vapor should penetrate to the farthest part of the cavity and destroy any stage of the borer that may be present.

A similar method has been used very successfully by the writer in destroying borers that were working in a piano. No treated burrow was ever opened.

TREATMENT FOR CLOTHES MOTHS AND FOR OTHER HOUSEHOLD INSECTS.

The various insects which commonly infest woolens, felts, furs, etc., often can be conveniently and surely destroyed by carbon disulphid, which will destroy all stages of the pests that may be present. In keeping woolens, felts, and furs, therefore, it is good practice to place them in a whole cotton bag (pillow case), tying it up tightly, and then store in a tight paper-lined trunk, a large packing box, or some such receptacle. (A water-tight barrel will do well.) When all are stored apply the disulphid, putting one-half cupful of the liquid into a shallow dish to evaporate or pouring it directly upon the materials if staining will not injure them. Newspapers or wrapping paper then should be spread over the top and the receptacle closed tightly. If the box is really tight there will be no further trouble, but to be on the safe side it is well to repeat the treatment once or twice during the summer. The odor disappears quickly when the articles are hung out in the open air again.

It is a good plan to provide for this treatment, which is needed in every home, by having an especially large, gas-tight and insect-tight packing chest with a very closely fitting cover. A hole should be bored through the cover and a small sponge, bunch of cotton waste, or similar absorbent material fastened below the opening on the inside. The chest may then be kept tightly closed and the carbon disulphid applied by pouring it through the opening, which thereupon is closed with a cork. The small cost of such an arrangement will soon be balanced by the convenience and security of the protection afforded. Carpets, rugs, blankets, woolen clothing, furs, etc., can be rid surely of all insect pests by inclosure for a few days in such a box. The dose used should be at the rate of at least 10 pounds to 1,000 cubic feet.

Among the numerous insects found in houses there are few that may not be reached successfully with carbon disulphid applied as directed for the fumigation of buildings. (See pp. 12–14.) Cockroaches, croton bugs, bedbugs, fleas, carpet beetles, etc., all can be destroyed by proper use of this liquid. The holds of large ships frequently are cleared of such pests, and also of rodents, in this manner.

DESTROYING MUSEUM PESTS.

Carbon disulphid is used very generally for the destruction of a number of insect pests which ruin museum specimens. Such specimens usually are inclosed in fairly tight showcases, trays, or boxes, and these can be treated rapidly and successfully simply by inserting the necessary amount of liquid and then closing doors or covers normally. In this way many museums are treated regularly as a measure of precaution, even though no pest is known to be present. Sometimes specimen trays or materials are placed in especially constructed, tight rooms or chests within which one general treatment reaches all of the contents. With this method care must be taken to see that boxes and trays are opened so that the vapor can diffuse through all of them.

SPECIES FACTOR IN INSECT RESISTANCE TO CARBON DISULPHID.

Great variation has been found in the resistance of different species of insects to carbon disulphid fumigation. This may be spoken of as the species factor and should always be considered in such work. Just as in the case of ordinary insect-killing bottles in which sodium cyanid is now used, the bumblebee probably is the easiest insect to kill with carbon disulphid. In a saturated atmosphere of disulphid at about 90° F. a bumblebee will die in a few seconds, while under the same conditions the cowpea weevil[1] will live for about 35 minutes, the rice weevil[2] for about 60 minutes, and the saw-toothed grain beetle[3] for about 120 minutes.

EFFECT OF CARBON-DISULPHID FUMIGATION UPON THE GERMINATION OF SEEDS.

It would appear from numerous tests that there is practically no danger of injuring germination in treating seeds that are well matured and dried out before treatment is given. *It would not be wise to treat moist seeds, or planting seed of any kind, during periods of very humid atmosphere*, as the seeds might take up enough moisture to make them liable to injury from the vapor.

SUBSTITUTES FOR CARBON DISULPHID IN FUMIGATION WORK.

A number of other volatile materials have been tested more or less carefully in the search for a fumigant that would be as effective as carbon disulphid and safer to handle on account of having nonexplosive qualities. Among this number carbon tetrachlorid is probably of largest value, but even with this material it is necessary to use several times as much as is required of carbon disulphid, and the fumigation to be effective is several times as expensive. It does not appear probable that any of these substitutes is likely to come into general use.

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[1] *Pachymerus chinensis* L. [2] *Calandra oryza* L. [3] *Silvanus surinamensis* L.

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GRAINS FOR THE DRY LANDS OF CENTRAL OREGON

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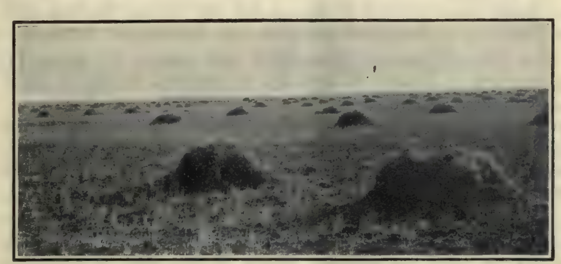

FARMERS' BULLETIN 800

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. April, 1917

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THIS bulletin discusses the production of small grains on nonirrigated lands in central and southeastern Oregon at elevations between 4,000 and 5,000 feet. The important crops for these dry-farmed lands are winter wheat and rye and spring wheat, rye, oats, and barley. Field peas are also of value as a legume for forage and grain. Dependence upon grain farming alone, however, is not advisable in this region; the grain crops should be grown for the winter feeding and the finishing of stock that are grazed on the near-by range.

The average annual rainfall in this section is about 11 inches, which usually is sufficient to produce crops on good soil which is well farmed. The principal drawback to crop production is the frequency of summer frosts. The nights are nearly always cool and frost may occur in any of the summer months. The frost-free period is seldom more than 40 or 50 days.

Winter wheat is the best of the cereal crops, especially on the valley silt loams and the plateau fine sandy loams. It should be sown on summer fallow at the rate of about 30 pounds to the acre. Only the hard red varieties, such as Turkey and Crimean, should be grown. When there is not sufficient moisture in the autumn to germinate winter wheat, spring wheat should be sown.

Rye is the principal crop now grown in central Oregon. Usually more grain is produced when it is sown in early spring than in the fall, for it is later in heading and more often escapes summer frosts.

Because of the distance from market and the low price per pound which can be obtained for oats and barley as compared with wheat, these grains should be grown only for feeding on the farms where they are produced. Sixty-Day oats and White Smyrna barley are the best varieties of these grains to grow.

GRAINS FOR THE DRY LANDS OF CENTRAL OREGON.

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PLACE OF THE GRAIN CROPS IN CENTRAL OREGON.

The future of the dry lands of central Oregon lies in a combination of crops with stock. The cultivated land will be used to produce feed for wintering and finishing stock that are grazed on the near-by range, only the surplus crops being sold. This will make dry farming succeed where otherwise it would be impossible.

In such a system of farming the growing of grains has a very important place. This bulletin therefore gives general information, based partly upon experiments at the Harney Branch Experiment Station at Burns, Oreg.,[1] concerning the production of the small grains on those nonirrigated lands of central Oregon which lie at altitudes between 4,000 and 5,000 feet. To lands which have the water table at a depth of 10 feet or less or which can be irrigated, the contents may apply in part. They apply only where the rainfall, summer frost, and winter cold are average and where the nature, depth, and alkali content of the soil are favorable for crop production. Market limitations and the needs of individual farmers are important factors also in determining the choice of crops among those that can be grown.

The important cereal crops for these dry-farming lands as a whole are winter and spring wheat, winter and spring rye, spring oats, and spring barley. Flax, field peas, and dry-land alfalfa are also of importance, but their place is not yet fully determined. Crops of minor importance which can be grown are emmer, spelt, rape, sweet clover, root crops, and potatoes. Crops which have been rather definitely proved to be unadapted to the average conditions are corn, millet, sorghum, beans, buckwheat, and cultivated grasses. Any crop which requires more than a very short growing season and is not resistant to frost and drought should not be attempted in more than an experimental way.

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[1] The Harney Branch Experiment Station was established at Burns, Oreg., in 1911. Harney County appropriated funds for the purchase of land, the erection of buildings, and the purchase of equipment. The work is conducted cooperatively by the Oregon Agricultural Experiment Station and the United States Department of Agriculture. Three years' results have now been obtained on summer-fallowed land.

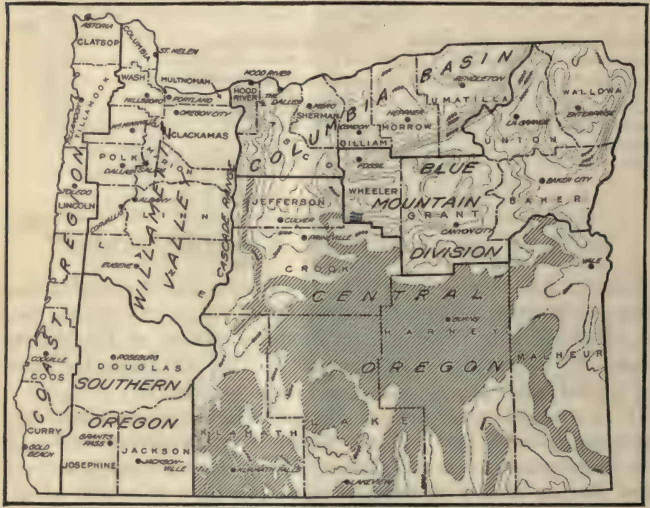

FIG. 1.—Map of Oregon, showing the principal divisions of the State, with contour lines up to 6,000 feet east of the Cascade Range. The shaded portion of the map shows the section to which this bulletin particularly applies, that part of central Oregon with altitudes between 4,000 and 5,000 feet.

DESCRIPTION OF CENTRAL OREGON.

The section commonly known as central Oregon covers about one-third of the State. It includes the southern half of that part of Oregon lying east of the Cascade Range (fig. 1). Its total area is about 26,000,000 acres, of which possibly 5,000,000 acres are arable. Probably 1,000,000 acres of the arable land can be irrigated eventually in some way. The area that must be dry farmed, if farmed at all, is therefore about 4,000,000 acres. The land that is fit only for range amounts to about 21,000,000 acres. At present, railroad transportation has barely touched the edge of this great area and comparatively few people are making their homes upon the nonirrigated lands.

TOPOGRAPHY.

Central Oregon is a region of great plateaus broken by wide, level valleys and low, well-weathered mountains or buttes, with few high mountains and few streams. Most of the tillable dry-farming land lies between elevations of 4,000 and 5,000 feet. Central Oregon lies in that division of the United States known as the Great Basin, from which there is no drainage to the sea. Both the water and the cold air from the mountains flow down into the valleys.

SOILS.

The tillable dry-farming soils of central Oregon probably can be described best as the valley silt loams, valley sandy loams, valley sands, and plateau fine sandy loams.

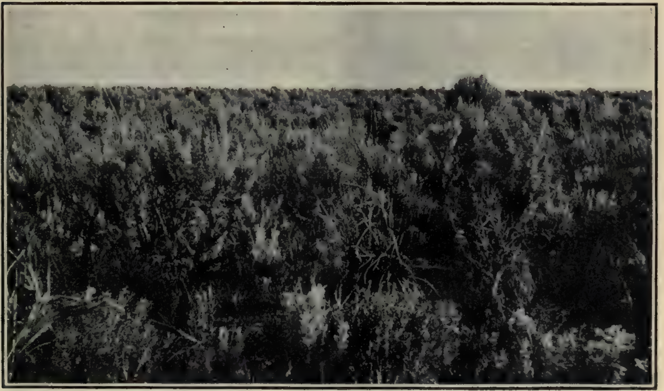

FIG. 2.—A vigorous growth of black sage in the Harney Valley in central Oregon, indicating fertility without excess of alkali.

VALLEY SILT LOAMS.

The valley silt loams include the heavier valley soils. They occur in practically all the valleys, large or small, and occupy probably about one-third of the entire valley area. Usually they are gray, brown, or black in color. The subsoil usually is quite heavy for a few feet, giving way to a more open soil at a depth of 6 feet or more. Hardpan may or may not be present. Water is found at depths of 10 to 200 feet, according to location. The native growth varies with the alkali content and other soil variations. A uniform growth of black sage (Artemisia), such as is shown in figure 2, is a fair indication of fertility without excess of alkali. Salt-grass (Distichlis), greasewood (Sarcobatus), and rabbit brush (Bigelovia) should be looked upon as a warning that injurious alkali may be present.

VALLEY SANDY LOAMS.

Those soils which are light enough to be tilled easily but not so sandy that they are moved much by the wind are classed as valley sandy loams. They occupy probably half of the total valley area. They are yellowish or brownish in color. The subsoil usually is somewhat heavier than the surface soil for a few feet and then becomes lighter, like that of the valley silt loams. The depth to water and the native vegetation, alkali content, and fertility are similar to those of the valley silt loams.

VALLEY SANDS.

The valley sands include those soils which are so sandy in character that they are blown about by winds. They are very easily tilled but otherwise difficult to handle. They comprise probably about one-sixth of the total valley area. The native vegetation, depth to water, and alkali content are similar to those of the other valley soils.

PLATEAU FINE SANDY LOAMS.

The plateau fine sandy loams, occurring on the hills and plateaus, are easily tilled, brown in color, and vary greatly in depth and subsoil condition. Water usually is not found before a depth of 100 feet is reached, and sometimes not within 300 or 400 feet of the surface. The native growth is principally black sage or black sage and bunchgrass. These soils are fertile and seldom contain much alkali. The important thing, aside from the variation in climatic conditions with locality, is that they be deep and without hardpan. There should be 3 to 4 feet of good soil to make these sandy loams suitable for farming.

CLIMATE.

The successful production of crops in central Oregon depends more on the climate than on any other factor, even though the altitude is not great and the Pacific Ocean not distant.

RAINFALL.

The average annual rainfall over the whole of central Oregon is about 11 inches. Most of this comes during the winter and spring months. Very little rain falls during the growing season. The rainfall varies markedly, however, even within short distances. Ordinarily, most of the moisture is absorbed by the soil, but there are times in the spring when the loss by run-off is great. This is true particularly on the valley silt loams and the steeper slopes of the plateau fine sandy loams. Sufficient moisture usually falls to produce crops on good soil, well farmed, in a locality having rainfall that is average or better. Snow lies on the ground for three or four months during the winter in some localities, thus affording excellent protection for hardy fall-sown grains. In other localities the ground remains covered for only a short time.

EVAPORATION.

The average evaporation from a free water surface at the Harney Branch Experiment Station at Burns is about 45 inches for the months from April to October, inclusive. Wind and heat increase the loss by evaporation. Good tillage and early-maturing crops are measures against crop failure. Evaporation during the winter months is slight.

WIND.

The average velocity of the wind is only about 4 miles an hour. At the Harney Branch Experiment Station it is highest in the spring months. The highest average velocity recorded at Burns for a 24-hour period in 1915 was 14.4 miles an hour on April 30. High winds, though not frequent, do considerable damage on the valley sandy soils by destroying young crops, cutting them off, blowing them out, or burying them when the sand moves with the wind.

TEMPERATURE.

The average daily mean temperature is about 44° F. This average daily mean temperature is from 5 to 10 degrees lower than that of the Columbia Basin, about 3 degrees lower than that of the Palouse section of eastern Washington and western Idaho, and from 2 degrees to 4 degrees lower than that of the Snake River basin of southern Idaho. It is about the same as the average daily mean temperature of eastern South Dakota and southern Minnesota. The average daily minimum temperature is about 27°, and the average daily maximum about 60° F. The highest summer temperature is rarely as much as 100° F., and the lowest winter temperature is rarely lower than −25° F. The days in summer are warm, but pleasant; with few exceptions the nights are cool.

The greatest problem in farming in central Oregon lies in the frequency of summer frosts. Except in favored places, summer frost rarely, if ever, fails to occur in June. It sometimes occurs in July, and seldom fails to occur before August 20. The favored places referred to are creek canyons and the slopes of hills where good air drainage is afforded or where the temperature is moderated by nearness to bodies of water. The average length of the growing season for such crops as corn is 40 to 50 days except in the comparatively small favored localities. Some crops are much hardier and under good management usually can be grown without serious damage.

AGRICULTURAL HISTORY.

The early settlers in central Oregon were stockmen. They selected land upon which wild grasses could be grown for hay to winter the stock that grazed on the ranges during the rest of the year. The ranges were overstocked and the native grasses were grazed so closely that they were largely destroyed. The annuals could not mature sufficient seed to reseed themselves, and the perennials were trampled out or pulled up. Reductions in the number of stock on the range came as the natural consequence.

The overgrazing of the ranges was followed by an influx of new settlers, who began fencing much of the range lands for dry farms. These new settlers did not engage in stock growing, but put their dependence on grain production. They were poorly equipped for farming. The cost of living and of crop production far from railroads was high, climatic factors were adverse, and rodent pests were numerous. Many settlers attempted to produce grain without putting the land in shape to make production possible. They failed, but the range had opportunity to regain much that it had lost.

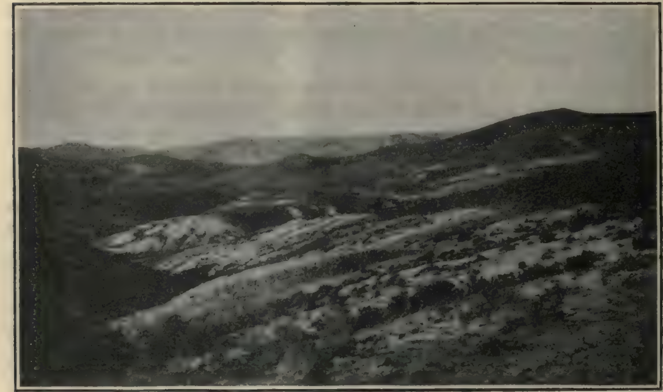

FIG. 3.—Mountain and hill land in Malheur County, Oreg. For every acre of tillable land in central Oregon there are many acres of this land that will always be range.

AGRICULTURAL POSSIBILITIES.

To-day the once boundless ranges of central Oregon are broken by the fences of settlers and by the remains of fences whose builders have gone. The day of the stockman who ranged his stock on a thousand hills and valleys is passing. With it is passing also the day of the man who depended on grain farming alone. It is a region of much Government land awaiting settlement, of much cheap deeded land, and of great areas of reviving range land. The day of the small stockman-farmer is at hand.

Transportation has not yet and may not soon come within practical hauling distance by wagon of most of this land. Even when it does, it is doubtful whether grain farming alone will be a profitable form of agriculture over most of this section. For every acre of land that can be cultivated there are many acres of range land (fig. 3). Any system that does not utilize both the tillable land and the range can hardly be fully successful.

Dry farming, to be successful, must be done right, and the ranges must be brought under control so that they can not be destroyed by overgrazing. With adapted crops of good varieties, with correct methods of production in use on the tillable lands, and with some system of controlled or rotation grazing for the range, central Oregon will produce many times as much wealth in live stock as it has in the past.

EQUIPMENT NEEDED FOR GRAIN GROWING ON DRY LANDS.

A farmer may buy more machinery than is needed or he may get the wrong kind or not buy enough. The average farmer should depend upon horses rather than engines for power. Horses can be kept quite cheaply if grazed on the range, and the value of colts may make them a real asset rather than an expense. The delay and expense of getting repairs and the high cost of fuel, due to the necessity of a wagon haul of 100 to 200 miles from the railroad, make traction engines a questionable investment at the present time for the average dry farmer in central Oregon.

Every farmer should have a plow, a disk harrow, a spike-tooth harrow, and a drill. The disk plow often is better than one of the moldboard type for central Oregon land, because it works better through the sticky spots. Disk plows also are better for plowing dry land. However, the type of plow which is most desirable depends to a considerable extent on the locality. The machinery in successful use in a neighborhood is a good guide in buying. The double-action disk harrows are best, the cutaway type being good where the land crusts badly. Any well-made spike-tooth harrow is good. A spring-tooth harrow mounted on high wheels and equipped with interchangeable teeth and teeth points can perhaps be substituted for both the disk and spike-tooth harrows on the average farm. The single-disk drill is better for trashy land and the double-disk and hoe drills for clean land.

Often several farmers can combine in buying the more expensive machinery, thus lessening the individual expense. Sometimes, also, it is cheaper to hire machinery from another farmer or to pay him to do certain work than to buy expensive machinery which will seldom be used.

ROTATION OF CROPS.

In planning a crop rotation for dry-farmed land in central Oregon, two questions should be kept in mind: (1) What combination of crops will give the greatest immediate return? (2) What will be the effect upon soil moisture, fertility, and future crops? If only the immediate return is considered, those crops should be chosen which are best adapted to the individual farm, and they should be sown in the order that will give the greatest return at the least cost. While it is important to have the permanent productiveness of the soil in mind, immediate profit is far more important to the average dry farmer in central Oregon under present conditions.

The desire for present profits, however, should not cause one to lose sight of future possibilities. To maintain the fertility of the soil, the rotation should include nitrogen-gathering crops, like peas, alfalfa, and sweet clover. If the immediate profit is about equal to that from a rotation including cereals only, no one can afford to omit the legumes.

In the selection of a rotation the individual farmer must consider: (1) The product which will pay best, whether hay to feed range stock in winter, grain to sell, or both; (2) the crops most likely to give the greatest quantity of the products wanted; (3) the order in which these crops shall follow each other; and (4) the tillage which shall be given the land.

No rotation practice can succeed on these lands if it does not include clean summer tillage. Whether this summer tillage must be given every other year or only once in three or more years has not yet been demonstrated fully. However, it is known that on the average the second grain crop after the summer fallow will be light. Usually it will be a failure. A cultivated crop or a very early maturing cereal which may be cut for hay if it fails to make grain might do. More information must be obtained before any cultivated crop can be recommended generally. Only those rotations are discussed, therefore, which include summer fallowing once in two or three years.

As already stated, the grain-producing crops adapted to central Oregon in general are wheat, rye, oats, and barley, with peas as a possible leguminous seed crop. The crops important for hay are rye, wheat, and oats, in the order named, with field peas and sweet clover as possible leguminous hay crops suited to short rotations. Alfalfa can not be considered in short rotations, for the reason that it should be kept on the land several years when a stand is once established.

TWO-YEAR ROTATIONS.

The 2-year rotation, fallowing half the land each year and cropping the other half, is the safest for the farmer who grows only one crop, whether wheat, barley, or oats. On a 320-acre farm the arrangement each year would be simply 160 acres of summer fallow and 160 acres of one or more of these crops. Where two or more crops are grown they should change places on the land the next time the land is cropped. In this way the same kind of crop might not be grown on the same field more than once in four or even six or eight years. Whether or not the 2-year is better than a 3-year rotation containing one year of fallow, one grain crop, and one hay or cultivated crop depends on many local conditions. It can not be answered fully here.

THREE-YEAR ROTATIONS.

Under the 3-year rotation plan one-third of the land would be summer-fallowed each year, one-third cropped to grain following summer fallow, and one-third used for some crop sown on stubble land, double-disked in the spring. This plan has the advantage of requiring plowing only once in three years and also gives a greater acreage of crop each year. It is of doubtful value, however, because few crops will make a profitable yield following a grain crop in average years. A crop which will produce a fair yield regularly on the stubble land must be had, or the yields from 320 acres in a 3-year rotation may be less than from a 2-year rotation. If the total production is the same from each rotation the labor cost also will be about equal. The best plan, then, is the one which gives the greatest average total product from the land.

The crops suited to follow the grain crop in the 3-year rotation must either mature early or be capable of intertillage, or both. Those which may be used in this way are rye, field peas, and possibly sweet clover. Spring rye or winter rye sown very early in spring is preferable to fall-sown rye on stubble land. Peas and sweet clover, if it is possible to grow them profitably, would give a leguminous crop, and the peas a cultivated crop as well.

For the grain farmer, the best 3-year rotation apparently is one-third fallow, one-third wheat, rye, oats, or barley sown on summer fallow, and one-third spring-sown rye on disked grain stubble. If peas for seed can be grown, a portion or all of the well-disked or fall-plowed stubble land can be sown to this crop, thus changing the kind of crop from time to time. For farmers who want hay only, the choice of crops would be the same, except that sweet clover might possibly be used. The farmer desiring both hay and grain may use any combination of the suggested crops suited to his needs, his soil, and his climatic conditions.

PREPARING THE LAND FOR GRAIN.

CLEARING AND PLOWING.

The ordinary sagebrush land of central Oregon can be cleared during the summer months at a labor cost of about $2 per acre. This is done by the use of a drag drawn by six or eight horses. The brush usually is dragged both ways and then burned where it falls. If the brush can not be burned in this way, it is raked into windrows with heavy sagebrush rakes. Clearing by hand costs about $5 per acre for labor, except when the brush is dry enough to burn as it stands. The first plowing should be done as soon after clearing as possible, in order to prevent new growth and to make the period for the storing of moisture as long as possible. The labor cost of breaking land in central Oregon is $2.50 to $3 per acre.

When stubble land is to be plowed, the work usually should be done in the fall or early in the spring. To delay plowing until late spring or summer allows the weeds to grow, and the moisture needed for crops is lost. When plowing can not be done early, disking as soon as possible in the spring will assist in holding moisture. The depth of plowing should be varied slightly from year to year. The land need not be plowed oftener than once in two years if other tillage, such as disking, is substituted. On very light soils and with certain cropping systems discussed elsewhere in this bulletin, plowing may be done only once in three years when other efficient but less costly tillage operations are performed.

SUMMER FALLOW ON SUMMER TILLAGE.

The dry-farming soils in central Oregon can not be cropped to grain continuously. This has been well demonstrated through experiment and farm experience. If a crop is grown on the land every year, the return will not be sufficient to pay the cost of production except where there is seepage from higher slopes or in years of unusually heavy rainfall. It has been shown, however, that paying crops can be grown by cropping the land one year in two. The other year is devoted to accumulating moisture and fertility by means of the summer fallow.

At the Harney Branch Experiment Station spring wheat has produced an average yield of 6.5 bushels per acre by continuous cropping in a 4-year test. This was produced at a net loss of $1.65 per acre per year. In arriving at this figure it is considered that the wheat was worth 75 cents per bushel at the farm and that the cost of production was $6.55. The experiment showed that when the land was summer-fallowed every second year the average crop harvested was 16.5 bushels per acre. Using the same values but increasing the cost of production to $9.80 to cover summer tillage, the higher harvesting and thrashing cost, and another year's interest and taxes, there remains a net gain of $2.57 for each acre cropped. On a 320-acre farm the returns under the first method would be $528 less than cost per year. Under the second method, where one-half the land is in crop each year, the returns are $411 per year above the cost of production, a difference of $939 per year in favor of the second method.

Summer tillage should prevent all weed growth and keep the soil surface rough and loose (fig. 4). This allows rain to be absorbed and prevents loss by run-off and evaporation. Stubble land should be plowed in the fall or early spring. Fall-plowed land and land that can not be plowed until late in the spring should be disked in early spring if possible, and then tilled with disk, spring-tooth, or spike-tooth harrow only as necessary to prevent weed growth and keep the surface soil in good tilth. A loose, cloddy surface is ideal. A dusty mulch blows, prevents ready absorption of rain, and crusts. Wherever possible, plow at right angles to a slope. The seeding of fall crops usually can be done without extra preparation of the fallow. If the soil has become badly crusted it will be necessary to disk in the early spring before seeding spring grain.

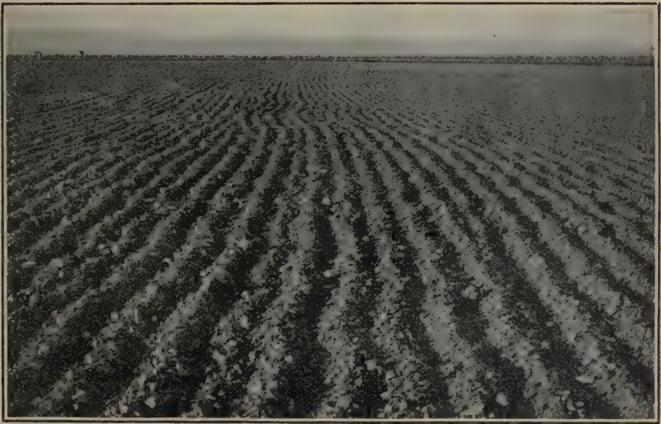

FIG. 4.—A perfect summer fallow, free from weeds, and with the surface soil rough and loose.

GOOD SEED.

The value of good seed can not be overestimated. To be good, seed must be of good quality and free from weed seed and shriveled kernels. It must be of a variety which is adapted to the soil and climatic conditions of the region, possessing earliness and hardiness. It must give the highest possible yield of the best quality. It must also be as free as possible from disease. A few additional cents per acre for good seed usually will be returned many times in the value of the crop. Specific statements as to varieties of the various grains which are adapted to this section and as to the best rates and dates of seeding are made in the discussion of the individual crops in the later pages of this bulletin.

TREATMENT OF SEED FOR SMUT.

Seed grain, unless definitely known to be free from smut, should be treated with a formaldehyde solution before seeding. The usual strength is 45 gallons of water to 1 pound of 40 per cent formaldehyde. The cleaned grain may be treated by sprinkling and shoveling until each kernel is moist. It may also be dipped and the smut balls skimmed from the surface of the liquid after stirring the grain to allow the smut to rise.[1] In either case the grain should be dried as quickly as possible. Care should be taken not to infect the seed again by using sacks or drills that have not been treated with formaldehyde. Always buy formaldehyde of standard strength, such as is supplied in sealed bottles.

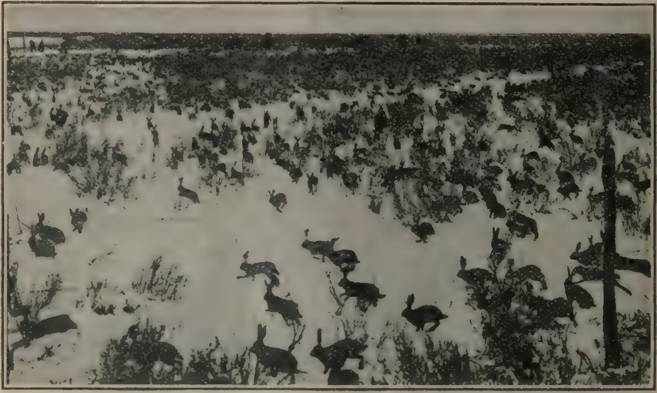

FIG. 5.—Jack rabbits brought together in a drive near Burns, Oreg. Although more than 20,000 rabbits were killed at this place, apparently just as many as ever were present when the crops were ready for harvesting the following summer.

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[1] For a more complete discussion of the formaldehyde treatment for grain smut, see Farmers' Bulletin 507, "The Smuts of Wheat, Oats, Barley, and Corn," a copy of which may be obtained free on request to the Secretary of Agriculture, Washington, D. C.

PESTS.

Jack rabbits and ground squirrels, locally known as sage rats, are the most common animal pests in central Oregon. These pests are numerous enough to do great damage to growing crops in some localities. Many methods of killing jack rabbits have been tried, with different degrees of success. Poisoning is effective when carried on extensively over large areas during the winter months. Rabbit drives, trapping, shooting, and snaring are seldom effective, because they are not conducted on a sufficiently large scale to affect materially the total number of rabbits. Some idea of the number of rabbits in this section can be gained from figure 5, which shows a portion of those brought together in a drive at Burns. The bounty plan has been tried in two or more counties in central Oregon with partial success but at considerable cost. Whatever plan is adopted, it should be prosecuted vigorously and on an extensive scale. A single county is small enough for an effective unit. It would be much better if all the counties would combine on a plan. When the pests are reduced in numbers the efforts should be much increased rather than discontinued. A fight of this kind will cost a great deal, but the money will largely be returned in increased crops. Every interest in central Oregon would be benefited, for the eradication of this pest would mean much in the development of farming and the restoration of the range. Until the jack rabbits are eradicated the only safety for growing crops over much of the territory is in fencing with rabbit-proof wire. This wire fencing should be not more than 1¼

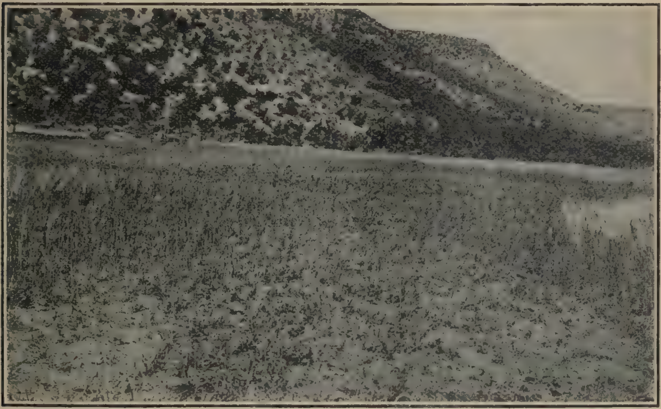

FIG. 6.—Grain field damaged by ground squirrels, locally known as sage rats. The early and liberal use of poison is the best insurance against loss of this kind.

inches between line wires in the lower foot, 1½ inches in the next 6 inches, 2 inches in the next 6 inches, and 2½ or 3 inches in the upper foot of a fence 3 feet in height. A closely barbed wire should be sunk in the ground about 2 inches, to prevent digging under. The fence then should be placed over it, with the lower wire tight to the ground. Two barbed wires above the woven wire, one of which should be quite near it, will make the fence effective against stock. Such a fence will often pay for itself within a short time in crops saved, especially on the more isolated farms.

The work of sage rats in a grain field is shown in figure 6. These pests can best be kept in check by the use of poisoned grain. The following formula is recommended by the Bureau of Biological Survey:

Strychnin alkaloid (powdered)	1 ounce.
Baking soda	1 ounce.
Gloss starch paste (thin)	1 pint.
Corn sirup	One-fourth pint.
Glycerin	1 tablespoonful.
Saccharine	1 teaspoonful.
Oats	20 quarts.

Mix the powdered strychnin, soda, and paste to a smooth, creamy mass. Stir in the sirup, glycerin, and saccharine. Apply to the grain and mix until each kernel is coated; then dry the product. Keep all occupied burrows on the farm and adjoining lands supplied once every week by scattering about one teaspoonful of the poisoned grain about each opening. The use of larger quantities is wasteful and is also dangerous to live stock. Early poisoning is very important. A cheap effective poison liberally used will do much to keep this pest in check.

At the present time insect pests are not a serious problem in central Oregon. Those which occur occasionally in sufficient numbers to cause damage to crops are cutworms and grasshoppers.

Cutworms may be destroyed when they appear by sowing poisoned bran mash late in the evening along the borders of the area eaten down. The following formula for preparing poisoned bran mash is taken from Farmers' Bulletin 739 of the U. S. Department of Agriculture: Mix 50 pounds of wheat bran, 2 pounds of Paris green, and 6 finely chopped oranges or lemons. Then bring the whole mixture to the consistency of a stiff dough by the addition of low-grade molasses, such as is used for feeding to cattle, adding water when necessary. Distribute this bran over the infested field in small lumps. If bran can not be obtained readily, middlings or alfalfa meal may be substituted.

When grasshoppers become numerous, they may be destroyed by using a similar poisoned bait composed as follows: Wheat bran, 25 pounds; Paris green, 1 pound; white arsenic, 1 pound; lemons or oranges, 6 finely chopped fruits; low-grade molasses or "blackstrap," 2 quarts. Ordinary table sirup should not be used for this purpose, as it is not attractive to grasshoppers. In the dry-land regions, water should be added to this bait at the rate of 4 gallons to 25 pounds of the mixture, as the extra moisture is necessary in order to attract the grasshoppers. It is also important to distribute this bait in the late afternoon or early evening, just before the grasshoppers ascend the plants on which they usually pass the night.

SMALL-GRAIN CROPS.

WHEAT.

Wheat is the best yielding grain crop to grow on land alternately cropped and fallowed in central Oregon on soils adapted to its culture. The valley silt loams, the plateau fine sandy loams, and, to a less extent, the valley sandy loams, are most suitable.

WINTER WHEAT.

Under proper conditions winter wheat will outyield all other cereal crops. While worthy of trial elsewhere, it is particularly adapted to the valley silt loams and the plateau fine sandy loams, but only in localities where snow lies on the ground throughout the winter and where frosts do not occur too regularly in late June and in July. Yields should average about 20 bushels to the acre on land previously well summer-fallowed. Yields, however, will vary greatly from year to year, according to the damage done by frosts during the time of heading and filling.

The Turkey winter wheat is best adapted, because of its hardiness, good yields, and the high quality of the grain for milling purposes. Seeding should be done on summer fallow at the rate of about 30 pounds of good seed per acre. Drill rather shallow about September 10 if the soil is moist enough to sprout the seed. The wheat should make a good start in the fall if it is to survive the winter in good condition. If the soil is dry, it may be better to sow spring grain, though very late fall seeding will sometimes succeed. Harrowing in the spring after growth has started well may help the crop under some conditions and may hurt it under others. Soil types and seasons vary so much that this question must be settled by each farmer for himself.

SPRING WHEAT.

Spring wheat is probably the most consistent yielder of all the grain crops where soils and climatic conditions are suited to its production. The crop is adapted particularly to the valley silt loams, the plateau fine sandy loams, and the heavier portions of the valley sandy loams. It is less likely to be injured by frost than winter wheat, because the period of heading and ripening comes later in the summer and does not last as long when early varieties are used. Sown on good summer fallow, it may be expected to average 15 to 20 bushels per acre. As a hay crop it hardly equals rye in yield under average conditions. The best variety now known for central Oregon is the Early Baart, which combines earliness with drought resistance and a high average yield of excellent milling wheat. Still better varieties may be found, but at present no mistake can be made in growing the Early Baart. For hay the Palouse Bluestem may be preferable, because it is beardless.

A spring-wheat variety must mature early to be adapted to extensive cultivation in central Oregon. Late varieties are frosted repeatedly before maturing; this results in low yields of shriveled wheat which produces flour of inferior quality. Good, plump wheat is necessary in order to assure a market.

It is poor policy for a community to grow a large number of varieties. If all farmers grow the same variety, the product will be more uniform, with consequent benefits in price.

Spring wheat should not be drilled deeper than is necessary to place the seed well into moist soil. Sow about April 15 to 20 at the rate of about 30 pounds of good seed per acre. It is not advisable to harrow the crop after it is up.

EMMER AND SPELT.

Winter emmer and spelt are not adapted to central Oregon conditions, because neither is hardy enough to survive the average winter. Spring emmer can be grown and will make fair yields, but it is not as good either in yield or in value per pound as wheat, oats, or barley. Until emmer and spelt have been tested more thoroughly, they should not be grown in this region unless in an experimental way.

RYE.

Rye is the principal crop now grown on the dry-farming lands of central Oregon. Probably it will continue to hold first rank in acreage for a long time, though wheat may yet outrank it in total production of grain.

WINTER RYE.

Winter rye is the only type of rye now grown in central Oregon to any considerable extent. The crop is sown both in the fall and in the early spring. When sown in the fall under proper conditions it usually survives the winter very well and makes an early growth in the spring. This earliness, however, unless checked by pasturing, very frequently results in the loss of part or all of the grain yield because of the frosting of the heads. When the crop is to be harvested for hay, this fact is slightly less important. When winter rye is spring sown, the development is slower and good yields of both grain and hay are more uniformly obtained than from the fall-sown winter rye. However, if sown in the spring, it must be sown very early or it will not succeed. If sown at the usual time of sowing spring grains, it will rarely get beyond the stooling stage except in unusually wet and cool summers.

As a fall-sown crop, winter rye is adapted particularly to the valley silt loams and plateau fine sandy loams where June and July frosts are rare and where there is usually a winter covering of snow. Under these conditions on well-fallowed land it may be expected to yield 12 or 15 bushels of grain or 1½ to 2½ tons of hay per acre. Where wheat is the first crop sown after fallow, rye is better than other cereals to sow on the disked stubble land if such a practice is adopted. Seeding should be done about September 10 to 15 at the rate of 30 to 60 pounds of good seed per acre.

Winter rye sown in early spring will succeed under nearly all soil and climatic conditions in that part of central Oregon under discussion where any grain crop would succeed. However, it is not always possible to seed it early enough and a delay of one or two weeks often results in failure. As good average yields may be expected as from fall-sown winter rye under like soil conditions. Since a winter covering of snow is not essential with spring-sown winter rye, it may be grown over a much wider area. It should be shallow drilled not later than April 1 at the rate of 30 to 60 pounds of good seed per acre.

The value of rye grain for feeding purposes is not quite equal to that of wheat, barley, or oats, pound for pound. It usually sells on the market, however, for about as much per pound as wheat. As a hay crop for wintering stock from the range, the value of the hay will be in proportion to the number of stock that the grower can winter on the product of his farm. Under good management the hay might bring the grower as much as $7 to $8 per ton when fed on the farm.

SPRING RYE.

Little or no true spring rye is being grown in central Oregon. True spring rye develops very rapidly when sown in the spring. It does not stool as much as winter rye and makes a shorter and finer growth of straw. The grain is also somewhat smaller than that of winter rye.

Spring rye is being tested at the Harney Branch Experiment Station, but the trials have not been conducted long enough to warrant a positive statement as to the usefulness of the crop in that locality.

So far as soils and climate are concerned it is adapted to as much of the dry-farming area of central Oregon as any grain crop. Its value will probably be greatest on the lighter soils and as a grain or hay crop on disked wheat stubble when the wheat follows fallow. Yields of hay and grain may be expected to be as good as or slightly better than those of early spring-sown winter rye. The crop should be drilled about April 20 at the rate of 30 to 60 pounds of good seed per acre, placed as shallow as possible to get the seed well into moist soil.

OATS.

The cool climate of central Oregon is favorable to oats, but the crop is not so drought resistant there as wheat. As a producer of grain in pounds per acre, oats may be expected to rank second to wheat under average conditions upon fallowed land. Where oats are needed at home, there is reason for growing the crop. As a market crop or as a feed crop for fattening meat animals, it does not have as high a value per pound as wheat.

WINTER OATS.

Winter oats will not survive the ordinary winter in central Oregon. Sown in the spring it is doubtful whether the yield would be as good on the dry lands as that from a good spring variety.

SPRING OATS.

Spring oats are best adapted to the valley silt loams. In seasons of favorable summer precipitation they will do well on the valley sandy loams and plateau fine sandy loams. When an early variety is seeded after April 15 heading does not occur till July and the crop is mature before August 10, so that little damage from frost is likely. On the soils adapted to the crop an average yield of about 30 bushels of grain per acre may be expected on summer-fallowed land. As a hay crop an average of 1 to 1½ tons per acre would probably be harvested.

The early small-kerneled Sixty-Day variety of oats is recommended for dry-farmed lands in central Oregon, especially for the production of grain. Seeding should be done from April 15 to 20 at the rate of 1 bushel of well-cleaned, plump seed per acre, drilled as shallow as possible, but placed well into moist soil.

BARLEY.

Barley is probably less adapted to central Oregon dry-farming lands than wheat, oats, or rye. Barley will do very well where the soil is usually quite moist and in seasons of abnormally heavy summer rainfall. Present information indicates that on the average it is not nearly as good as wheat for the production of grain and is slightly less valuable than oats.

WINTER BARLEY.

Winter barley will not survive the average winter in central Oregon. When it survives, June and July frosts usually catch the crop in head. When spring sown it has not given as good results as good spring varieties.

SPRING BARLEY.

The importance of spring barley lies principally in supplying special local demands. Sold on the market, it usually brings less per pound than wheat or oats. Fed to fattening meat animals, it is about equal to wheat in value per pound. The crop is adapted to the valley silt loams particularly and can be grown on lighter soils when the summer rainfall is favorable. Barley is subject to frost injury, requiring late seeding to prevent heading before the last spring frosts. An average grain yield of 18 to 20 bushels per acre may be expected on summer-fallowed land where the soil is adapted to the crop.

The White Smyrna variety is probably the best adapted to the average central Oregon dry farm. This variety is very early and of good quality. Its short straw is an advantage from the standpoint of grain production. Seeding should be done about May 1 at the rate of 40 pounds of good seed, drilled as shallow as possible, but deep enough to place the seed well into moist soil.

FLAX.

The growing of the flax crop is yet in the experimental stage in central Oregon. Experiments conducted during the last three years indicate that it is quite frost hardy and that it is adapted to the heavier soil types. With improved transportation facilities, flax is a possible cash crop on soils adapted to its growth for use in rotation with other crops. A 3-year average yield of 6.6 bushels per acre has been obtained at the Harney Branch Experiment Station. The price per bushel on the farm may be expected to average from $1.25 to $1.50.

The best variety of flax to grow in this section has not yet been determined. Seeding probably is best done early in May at the rate of 16 pounds per acre, drilled shallow in a fine, firm, moist seed bed.

RANK OF SMALL-GRAIN CROPS.

Any ranking of crops adapted to central Oregon according to their importance must be qualified with the understanding that the ranking applies to the region as a whole. Under local variations of soil, rainfall, frost, winter snow covering, transportation facilities, range conditions, actual products wanted, etc., the ranking given may or may not hold.

From the standpoint of grain production the adapted cereal crops rank in importance in the following order: Wheat, rye, oats, barley.

From the standpoint of yield and value when cut for hay the adapted cereal crops rank as follows: Rye, wheat, oats, barley.

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